Reg. U. S. Pat. Off.

EXECUTIVE COMMITTEE

President
H. J. BALL

Vice-Presidents
DEAN HARVEY — P. H. BATES

Secretary-Treasurer
C. L. WARWICK

Members of Executive Committee
R. P. ANDERSON — ALEXANDER FOSTER, JR.
M. H. BIGELOW — L. H. FRY
ARTHUR W. CARPENTER — C. D. HOCKER
T. A. FITCH — J. L. MINER
J. H. FOOTE — E. W. UPHAM

Past-Presidents
H. H. MORGAN — W. M. BARR
G. E. F. LUNDELL

COMMITTEE ON PAPERS AND PUBLICATIONS

This committee has authority in all matters affecting the acceptance, rejection, editing and publication of papers, committee reports, and discussions. The committee also acts in an advisory capacity to the Executive Committee in publication matters in general.

C. L. WARWICK, *Chairman*
J. R. FREEMAN, JR. — C. E. HEUSSNER
W. H. GARDNER — E. F. KELLEY
J. C. GENIESSE — P. G. McVETTY
H. J. GILKEY — H. S. RAWDON
STANTON WALKER

Correspondent Members from Pacific Coast District
F. J. CONVERSE — R. E. DAVIS

ADMINISTRATIVE AND EDITORIAL STAFF

C. L. WARWICK
Secretary-Treasurer
J. K. RITTENHOUSE — *Assistant Treasurer*
R. E. HESS — *Assistant Secretary*
P. J. SMITH — *Standards Editor*
R. J. PAINTER — *Assistant to the Secretary*
G. A. WILSON
Assistant Editor

ASTM BULLETIN

Published by
AMERICAN SOCIETY for TESTING MATERIALS

This Issue Contains

Committee on Standards Approves 32 New Specifications and Tests 5

Use of Filter Press in Preparing Samples for Soil Tests, *by J. L. Byers* 11

A Cotton Fiber Strength Tester, *by E. H. Pressley* 13

Stress-Strain Relations in Timber Beams, *by Albert G. H. Dietz* 19

Discussion of Terminology Relative to Volume and Specific Gravity of Granular Materials for Concrete 28

Report on Air-Permeability Method for Determining Fineness of Cement 31

Effect of Size of Specimen in Studies of Durability of Concrete as Affected by Aggregates, *by Stanton Walker and Fred F. Bartel* 37

Masthead:
Relentless Tester; Increased Membership. 40

Joint A.W.S.-A.S.T.M. Committee on Filler Metal Organized 42

National Emergency Steel Work on Heavy Forgings 43

Long-Time Society Committee Members 46

Emergency Standard for Design and Erection of Structural Steel 47

Cement Order Amended; OPA Standards Division; WPB Specifications Branch 48, 49

More New Emergency Alternate Provisions . . . 51

New Members; Personals 56, 57

Complete List of Emergency Specifications and Emergency Alternates (Pink Slips) 59

Necrology 60

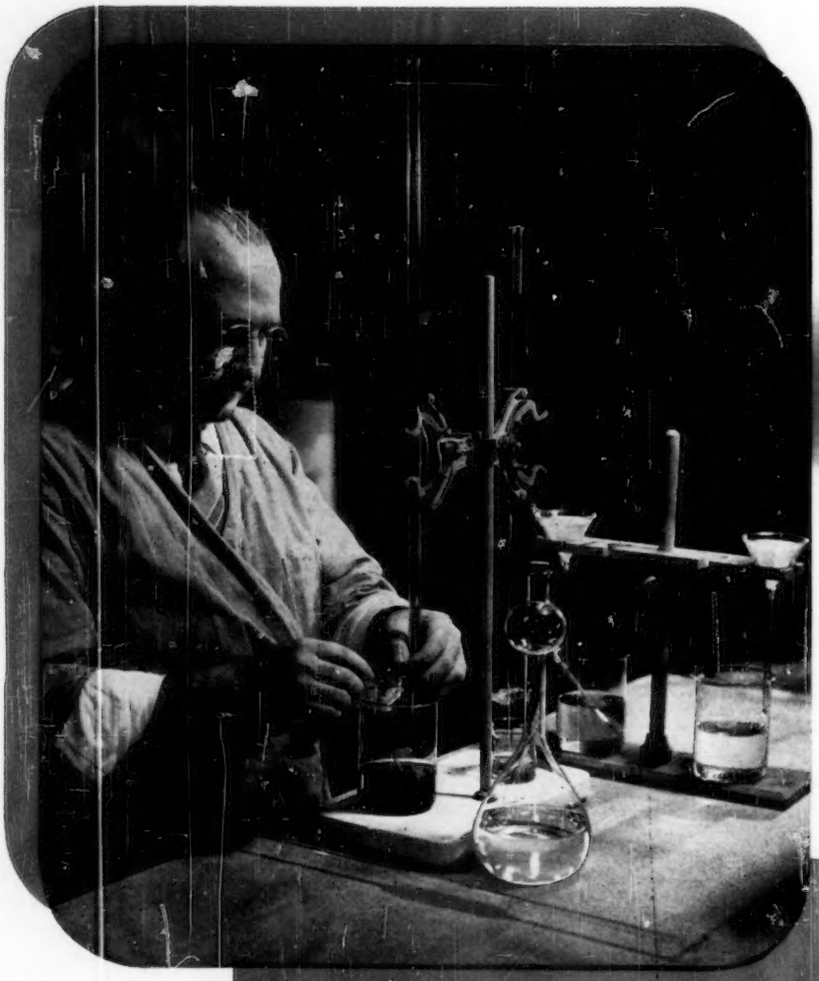
Index to Advertisers 55

ASTM Bulletin, October 1942. Published six times a year, January, March, May, August, October, and December, by the American Society for Testing Materials. Publication Office—20th and Northampton Sts., Easton, Pa. Editorial and advertising offices at the headquarters of the Society, 260 S. Broad St., Philadelphia, Pa. Subscription $1.50 a year in United States and possessions, $1.75 in Canada, $2.00 in foreign countries. Single Copies—25 cents. Number 118. Entered as second class matter April 8, 1940, at the post office at Easton, Pa., under the act of March 3, 1879.

Copyrighted, 1942, by the American Society for Testing Materials.

OCTOBER—1942

No. 118



For Assurance

DEPENDABLE EQUIPMENT for Vital Work

The chemist and laboratory worker to-day must depend on equipment that not only meets specifications of design and performance, but keeps on meeting them. There is no time for needless delay due to breakage and replacement.

Kimble Laboratory Glassware

is correctly ANNEALED to assure maximum strength, sturdiness and resistance to breakage, cutting down waste of urgently needed time and material.

STOCKED BY LEADING LABORATORY SUPPLY HOUSES THROUGHOUT THE UNITED STATES AND CANADA.

You will be heartily welcome at our Booth No. 142 at the National Chemical Exposition, Hotel Sherman, Chicago, November 24 to 29, 1942.

KIMBLE GLASS COMPANY . . . . VINELAND, N. J.

NEW YORK · CHICAGO · PHILADELPHIA · DETROIT · BOSTON · INDIANAPOLIS · SAN FRANCISCO

ASTM BULLETIN

"Promotion of Knowledge of Materials of Engineering and Standardization of Specifications and Methods of Testing"

TELEPHONE—PENnypacker 3545 CABLE ADDRESS—TESTING

R. E. Hess, Editor

R. J. Painter, Associate Editor

Number 118 October, 1942

Committee on Standards Approves 32 New Specifications and Tests

Numerous Revisions and Emergency Alternate Provisions Developed to Keep Standards Up to Date

As a result of recommendations from numerous A.S.T.M. standing committees, the Committee on Standards at its meeting on August 24 approved a large number of new tentative specifications and also took action on several new emergency specifications. Some few actions were taken by letter ballot of Committee E-10, and including these, 32 new tentative specifications and tests were issued, of which 13 are emergency specifications. In an effort to keep specifications in line with industrial practice 15 revisions of standards and tentative standards have been accepted and a large number of emergency alternate provisions have been approved.

In order that members may keep a clear distinction between the regular actions, as contrasted with emergency specifications and emergency alternate provisions, the latter are described in a separate part of the article. Two complete lists are given—one, the regular tentative specifications and revisions; the second list gives the new emergency specifications and the emergency alternates, or so-called "pink slips."

"Regular" New Tentative Specifications and Revisions

"A"—Ferrous Metals

Cast Iron.—A note in connection with the new recommended practice for making torsion tests of cast iron (A 260 – 42 T) explains the importance of this measurement since it is used in connection with applications in cam shafts, crank shafts, couplings, and similar service, and from the torsion test results such values as modulus of rupture, shearing modulus of elasticity, and permanent angle of twist can be computed.

Corrosion.—The revisions in tentative specifications for zinc coating (hot-dip) on hardware and fastenings (A 153 – 33 T) limit the weight of coating test to pieces the areas of which can be readily calculated. The number of dips for certain grades of materials were increased bringing them in line with recent consumer requirements and a section on embrittlement has been added directing attention to precautions that should be taken by the hardware manufacturer prior to galvanizing.

Magnetic Properties.—In its annual report Committee A-6 on Magnetic Properties had included for information three proposed methods covering the following: permeability of feebly magnetic materials, permeability and core loss of flat-rolled magnetic materials at low alternating inductions using 28-cm. specimen, and permeability and core loss of flat-rolled magnetic materials using 28-cm. specimen.

Urgent need of standardized requirements led the committee to vote on these subsequent to the meeting and in view of the affirmative returns they have been approved as new A.S.T.M. tentative standards. The first named test (A 259 – 42 T) gives two procedures for materials having permeability slightly greater than 1.0 but not over 2.0. The second test (A 258 – 42 T) covers properties which are indicative of the effects of the material on the impedance and loss characteristics of apparatus in which the material is used and subjected to alternating magnetization superimposed upon steady unidirectional magnetization; while the third test (A 257 – 42 T) is applicable to flat-rolled magnetic materials at commercial power frequencies and inductions up to 18 kilogausses.

"B"—Non-Ferrous Metals

Copper and Copper Alloys, Cast and Wrought.—The revisions in the tentative specifications for phosphor bronze rods, bars, and shapes (B 139 – 41 T) and for phosphor bronze wire (B 159 – 41 T) are similar in some respects including the lowering of the tin content from 3.80 to

Complete List of All Emergency Specifications and Emergency Alternate Provisions (Pink Slips)

Beginning with this issue, and henceforth, each ASTM BULLETIN will carry a complete list of the emergency specifications and emergency alternate provisions. This list will appear immediately preceding the professional card page in the back advertising section.

ACTIONS BY COMMITTEE E-10 ON STANDARDS

NEW TENTATIVE STANDARDS

Ferrous Metals

Recommended Practice for (Committee A-3):
Making Torsion Tests of Cast Iron (A 260 – 42 T).
Method of Test for (Committee A-6):
Measuring Permeability and Core Loss of Flat-Rolled Magnetic Materials Using 28-CM. Specimen (A 257 – 42 T).
Incremental Permeability and Core Loss of Flat-Rolled Magnetic Materials at Low Alternating Inductions Using 28-CM. Specimen (A 258 – 42 T).
Permeability of Feebly Magnetic Materials (A 259 – 42 T).

Manufactured Masonry Units

Method of (Committee C-15):
Test for Initial Rate of Absorption (Suction) and Efflorescence of Brick (C 67 – 42 T).

Paint, Varnish, Lacquer, and Related Products

Specifications for (Committee D-1):
Isopropyl Acetate (D 657 – 42 T).
Method of (Committee D-1):
Evaluating Degree of Chalking of Exterior Paints of the Linseed Oil Type (D 659 – 42 T).
Evaluating Degree of Checking of Exterior Paints of the Linseed Oil Type (D 660 – 42 T).
Evaluating Degree of Cracking of Exterior Paints of the Linseed Oil Type (D 661 – 42 T).
Evaluating Degree of Erosion of Exterior Paints of the Linseed Oil Type (D 662 – 42 T).

Road and Paving Materials

Specifications for (Committee D-4):
Crushed Stone, Crushed Slag, and Gravel for Bituminous Concrete Base and Surface Courses (D 692 – 42 T).
Crushed Stone, Crushed Slag, and Gravel for Water-Bound Base and Surface Courses (D 694 – 42 T).

Plastics

Methods of (Committee D-20):
Test for Compressive Strength of Plastics (D 695 – 42 T).
Test for Coefficient of Linear Thermal Expansion of Plastics (D 696 – 42 T).
Test for Water Vapor Permeability of Plastic Sheets (D 697 – 42 T).

Soils

Method of (Committees D-18 and D-4):
Test for Moisture-Density Relations of Soils (D 698 – 42 T).

Methods of Testing

Definitions of Terms (Committee E-1):
With Tables and Related Data on Conditioning and Weathering (E 41 – 42 T).
Specifications for (Committee E-1):
Carbon Arc Accelerated Weathering Unit (E 42 – 42 T).

Nomenclature and Definitions

Definitions of Terms (Committee E-8):
Relating to Heat-Treating (E 44 – 42 T).

REVISIONS IN EXISTING TENTATIVE STANDARDS

(Incorporated Immediately)

Tentative Specifications for:
Zinc Coating (Hot-Dip) on Hardware and Fastenings (A 153 – 42 T).
Phosphor Bronze Rods, Bars, and Shapes (B 139 – 42 T).
Phosphor Bronze Wire (B 159 – 42 T).
Standard Sizes of Coarse Aggregate for Highway Construction (D 448 – 42 T).
A.S.T.M. Thermometers (E 1 – 42 T).
Tentative Methods of:
Sampling Stone, Slag, Gravel, Sand, and Stone Block for Use as Highway Materials (D 75 – 42 T).
Testing Molded Materials Used for Electrical Insulation (D 48 – 42 T).
Test for Power Factor and Dielectric Constant of Electrical Insulating Materials (D 150 – 42 T).
Testing Solid Filling and Treating Compounds Used for Electrical Insulation (D 176 – 42 T).
Surveying and Sampling Soils for Highway Subgrades (D 420 – 42 T).
Tension Testing of Plastics (D 638 – 42 T).
Test for Softening Point (Ball and Shouldered Ring Apparatus) (E 28 – 42 T).

TENTATIVE REVISIONS OF STANDARDS

(Not incorporated, but published for comment)

Standard Specifications for:
Hollow Load-Bearing Concrete Masonry Units (C 90 – 39).
Zinc Oxide (D 79 – 41).
Standard Methods of:
Chemical Analysis of Limestone, Quicklime, and Hydrated Lime (C 25 – 29).
Mechanical Analysis of Soils (D 422 – 39).

WITHDRAWALS

Standard Specifications for:
Seamless Cold-Drawn Alloy-Steel (4 to 6 per cent Chromium) Heat-Exchanger and Condenser Tubes (A 187 – 40).
Seamless Alloy-Steel (4 to 6 per cent Chromium Still Tubes for Refinery Service (A 188 – 40).
Curing Portland Cement Concrete (C 80 – 34).
Crushed Slag for Bituminous Concrete Base and Surface Courses (D 485 – 38 T).
Crushed Stone for Bituminous Concrete Base and Surface Courses (D 486 – 39 T).
Crushed Slag for Water-Bound Base and Surface Courses (D 488 – 38 T).
Crushed Stone for Water-Bound Base and Surface Courses (D 489 – 40 T).
Gravel for Bituminous Concrete Base (D 309 – 30).
Standard Methods of:
Curing Portland Cement Concrete Slabs with Bituminous Coverings (C 81 – 36).
Curing Portland Cement Concrete with Calcium Chloride Admixture (C 82 – 38).
Curing Portland Cement Concrete Slabs by Surface Application of Calcium Chloride (C 83 – 38).
Curing Portland Cement Concrete Slabs with Wet Coverings (C 84 – 36).
Definition of Terms:
Relating to Heat Treatment Operations (Especially as Related to Ferrous Alloys) (A 119 – 33).

3.50 to be in agreement with certain other specifications including Federal and Navy, and in view of the approval in the Federal Specifications of the hot-rolling type phosphor bronze in sizes 1.25 in. in diameter and over, this revision was inserted.

"C"—Cementitious and Related Materials

Lime.—Committee C-7 has been at work for some time on the development of a rapid sugar test for determining available lime in high-calcium quicklime and hydrated lime, and with reasonably good agreement in the committee the methods have been established as tentative revisions of the existing standard C 25 covering chemical analysis of limestone, quicklime, and hydrated lime.

Concrete and Concrete Aggregates.—Through the work of Committee C-9 five methods covering curing of portland cement concrete and slabs have been issued by the Society, but as announced some time ago the A.S.T.M. and American Concrete Institute have agreed on coordination of certain work and since recommended practices are considered to fall within the A.C.I., the standards are being withdrawn since the Institute has set up machinery for accepting jurisdiction on this general subject. Its new Committee 612 includes nine members of whom five are active in the work of Committee C-9.

Manufactured Masonry Units.—Although issued as a new tentative standard, the procedure covering initial rate of absorption and efflorescence of brick (C 67 – 42 T) is considered a tentative revision of the standard methods of sampling and testing brick (C 67 – 41). This test is primarily a visual test, the bricks being inspected after partial immersion in water.

The tentative revision of the specifications for hollow load-bearing concrete masonry units (C 90 – 39) provides a Grade A unit for below-grade walls, or exterior above-grade walls. The specification had included a so-called escape clause by which units not exposed to the weather or soil but were suitably protected need not conform to the absorption requirements specified. This has now been changed by classifying the material as Grade B. Another modification increases strength requirements for units exposed to the soil or weather from 700 to 1000 psi.

"D"—Paint, Varnish, Lacquer, etc.

Paint and Paint Materials.—Of the five new tentative standards approved on the recommendation of Committee D-1 four pertain to evaluating the degree of deterioration of coatings, the tests covering exterior paints of the linseed oil types involving checking (D 660), chalking (D 659), cracking (D 661), and erosion (D 662). The fifth item provides specification requirements for isopropyl acetate (D 657). There is an urgent need for a uniform generally used system of reporting deterioration of coatings which these new methods provide. The new specification covers low boiling solvents a use of which has greatly increased due to the needs of the Army for quick drying coatings.

A revision in the standard specifications for zinc oxide (D 79 – 41) will provide a standard A.S.T.M. requirement for a grade of material used by the Navy. The other recommendation of D-1, revision of specifications for basic sulfate white lead (D 82 – 41) by which the specification is reverted to tentative, incorporates an emergency alternate provision now withdrawn permitting reduction in lead oxide from the present minimum value of 15.0 to 11.0.

Road and Paving Materials.—Two new specifications were accepted on the recommendation of Committee D-4, one covering gravel for bituminous concrete base and surface courses, and one for water-bound base and surface courses. The mechanics involved were to incorporate in previously existing standards, which cover the use of crushed stone and slag, requirements on gravel and to issue these as new specifications, as follows:

Tentative Specifications for Crushed Stone, Crushed Slag, and Gravel for Bituminous Concrete Base and Surface Courses (D 692 – 42 T)
Tentative Specifications for Crushed Stone and Crushed Slag for Bituminous Macadam Base and Surface Courses (D 693 – 42 T)
Tentative Specifications for Crushed Stone, Crushed Slag, and Gravel for Water-Bound Base and Surface Courses (D 694 – 42 T)

Electrical Insulating Materials.—The major change in the tentative methods of testing molded materials used for electrical insulation (D 48 – 41 T) involves the specimen to satisfy tests used for higher frequencies, and similar modifications in the specimen were necessary in the test for power factor and dielectric constant of electrical insulating materials (D 150 – 41 T) to provide for certain types of measuring equipment. Changes in the test of solid filling and treating compounds (D 176 – 40 T) make it more applicable for materials to which the test is being applied at the present time.

Soils.—A new test for moisture density relations of soils was developed jointly by Committees D-4 and D-18 and was accepted on September 17 by letter ballot of Committee E-10.

This method (D 698 – 42 T) is intended for determining the relationship between the moisture content of soils and resulting densities (oven-dry weight per cubic foot) when the soil is compacted in the laboratory as specified herein.

The method covering determination of specific gravity was not approved by Committee E-10 since certain negative votes had been received. Modifications were accepted in the method of surveying and sampling soils for highway subgrades (D 420 – 42 T) clarifying certain portions and extending the scope to apply to airport runways, parking, or taxiway areas.

Moisture-Density Relations of Soils.—This new tentative method, D 698 – 42 T, is used to determine relationship between the moisture in soils and resulting density in the soil as compacted in the laboratories as specified in the standard. The method was developed jointly in Committee D 18 and Committee D-4.

Plastics.—Three new tentative standards were approved as a result of active work in Committee D-20 on Plastics as follows:

D 695 – 42 T—Method of Test for Compressive Strength of Plastics
D 696 – 42 T—Method of Test for Coefficient of Linear Thermal Expansion of Plastics
D 697 – 42 T—Method of Test for Water Vapor Permeability of Plastic Sheets

The group of active technologists representing leading consumers and producers of plastics on Committe D-20 have worked intensively to develop satisfactory tests, and have accelerated their work because of the national emergency, which has stressed the necessity of adequate

evaluation of these materials so critical in a number of uses. The test for compressive strength is intended for determining the comparative compressive properties of organic plastics in the form of test specimens of standard shape when tested under defined conditions of pretreatment, temperature, humidity, and testing machine speed. The test specimen may be compression or injection-molded into its final form or it may be machined from sheets, slabs, plates, rods, or similar shapes prepared by any suitable method.

The test for coefficient of linear thermal expansion in its scope indicates that under conditions of industrial applications, the thermal expansion of a plastic is composed of a reversible component on which are superimposed changes in length due to changes in moisture content, curing (degree of polymerization), loss of plasticizer or solvents, release of stresses and so on. This method is intended to determine the reversible linear thermal expansion under exclusion of these accidental factors. However, in general, it will not be possible to exclude all these accidental factors and for this reason the method can be expected to give only approximate values.

The test for water vapor permeability applies to paper, paper board, transparent sheeting, plastic sheeting, and other sheet materials.

Two other proposed tests were submitted by the committee but because of divergent opinions in the group, action was postponed. These were to cover accelerated service testing of plastics and determining the permanent effect of heat on plastics.

A number of revisions were incorporated in the existing Tentative Methods of Test for Tensile Properties of Plastics (D 638). This important test covers definition of terms, equipment and grips, conditioning requirements, and so forth.

"E" Group

Definitions of Heat Treating Terms.—Prepared by a Joint Committee on Definitions of Terms Relating to Heat Treatment, the Tentative Definitions of Terms Relating to Heat Treating (E 44) supersedes the existing standard A 119 and provides an up-to-date version of the large number of terms covered.

Conditioning and Weathering.—Through its Subcommittee X on Conditioning and Weathering, Committee E-1 on Methods of Testing developed a new tentative standard covering characteristics of a standard carbon arc accelerated weathering unit (E 42). The outline given covers points of fundamental importance to provide an acceptable accelerated unit for various problems. Other important items in this field are the new tentative definitions, tables and related items in conditioning and weathering (E 41).

Changes in the Tentative Method of Test for Softening Point (Ball and Tapered Ring Apparatus) (E 28) were approved by which a ring with a shoulder is now recommended. This is particularly desirable because certain resins on cooling contracted, which resulted in the sample dropping slightly in the ring.

Emergency Standards and Emergency Alternate Provisions

As indicated above, the Committee E-10 on Standards on August 24 approved 12 emergency standards in the field of thermal insulating materials, and by letter action as of October 6, another important emergency standard in the metals field, covering malleable iron flanges, fittings, and valve parts received favorable action. There has been considerable activity by Committee A-1 on Steel in cooperation with the National Emergency Steel Specification project in developing emergency alternate, changes in chemical composition and other requirements affecting production, so that procurements can be expedited.

Titles and serial designations of the new emergency specifications and the emergency alternate provisions appear in the accompanying table.

Many of the EA's (pink slip changes) are published in the back portion of this Bulletin (see page 51).

Emergency Specifications (ES) for Thermal Insulation

Concerning the twelve new emergency specifications submitted by Committee C-16 on Thermal Insulating Materials—at its spring meeting the committee considered carefully the emergency situation, the lack of specific standard requirements, and the urgent need for them. Work had been under way for some time in organizing data and reaching a consensus between consumer and producers active in the work. In March the committee "took the bull by the horns" and appointed several groups responsible for developing specifications promptly in specific fields, and at the June sessions lengthy meetings resulted in fairly complete drafts of the specifications. The committee feels that while the specifications should not at this stage be given the status of standards they would be very useful, and under the stress of the present emergency would be particularly valuable. They will, of course, form the basis ultimately for permanent specifications.

To convey some concept of the titles covered, abbreviated scopes of the specifications are given here.

Emergency specifications ES – 8 through ES – 12 cover material of the indicated variety, usually in the form of dry cement or plaster, intended to be mixed with a suitable portion of water, applied as a plastic mass, and dried in place for use on surfaces at the temperatures indicated.

ES – 8: 85 per cent magnesia thermal insulation for use on surfaces between 212 and 600 F.

ES – 9: Material predominantly of asbestos fiber affords substantial resistance to heat transmission of surfaces between 200 and 1000 F.

ES – 10: Material composed predominantly of mineral wool affords substantial resistance to heat transmission on surfaces between 200 and 1200 F.

ES – 11: Material predominantly expanded or exfoliated mica for use on surfaces between 200 and 1800 F.

ES – 12: Material predominantly of diatomaceous earth, for use on surfaces between 600 and 1200 F.

ES – 13: Material predominantly of calcined diatomaceous earth, for use between 1200 and 1900 F.

ES – 14: Blanket or batt insulations in flexible or semirigid form for flat or curved surfaces.

ES – 15: Blanket materials for industrial purposes for surfaces where temperatures exceed 100 F.

New Emergency Specifications

ES – 8 Emergency Specifications for 85 Per Cent Magnesia Thermal Insulating Cement

ES – 9 Emergency Specifications for Long Fiber Asbestos Insulating Cement

ES – 10 Emergency Specifications for Mineral Wool Thermal Insulating Cement

ES – 11 Emergency Specifications for Expanded or Exfoliated Mica Insulating Cement

ES – 12 Emergency Specifications for Diatomaceous Earth Thermal Insulating Cement, for Use from 600 to 1200 F.

ES – 13 Emergency Specifications for Diatomaceous Earth Thermal Insulating Cement, for Use from 1200 to 1900 F.

ES – 14 Emergency Specifications for Blanket Thermal Insulation for Building Purposes

ES – 15 Emergency Specifications for Blanket Insulation for Industrial Purposes

ES – 16 Emergency Specifications for Blanket Thermal Insulation for Refrigeration

ES – 17 Emergency Specifications for Preformed Pipe Covering

ES – 18 Emergency Specifications for Preformed Block Insulation

ES – 19 Emergency Specifications for Structural Board Insulation

(Specifications ES – 8 through ES – 19 approved by Committee E-10 on August 24, 1942.)

ES – 20 Emergency Specifications for Malleable Iron Flanges, Pipe Fittings, and Valve Parts

(Approved by letter ballot of Committee E-10 on October 6, 1942)

Revised Emergency Specifications

ES – 5a Emergency Specifications for Carbon-Chromium, Ball and Roller-Bearing Steels (Superseding issue of April 28, 1942)

Withdrawals

ES – 4 Emergency Standard Hardness Conversion Table for Cartridge Brass

(Status changed to permanent standard E 33 – 42.)

ES – 16: Blanket materials in flexible or semirigid form for flat or curved surfaces.

ES – 17: Preformed molded or laminated material in the form of semi-cylindrical pipe covering sections, for use at specified temperatures.

ES – 18: Preformed block for application as received, excluding bricks of the 9-in. series. Three grades are covered as determined by the compressive strength.

ES – 19: Designates the physical property values of board insulation and the methods of determining.

Malleable Iron Fittings

The new Specification ES – 20 covers malleable iron flanges, pipe fittings, and valve parts, including parts to be assembled, manufactured in advance, and supplied

List of Emergency Alternate Provisions—Issued Since July 29, 1942

Specifications for Boiler and Superheater Tubes

EA – A 83 Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes

EA – A 178 Electric-Resistance-Welded Steel and Open-Hearth Iron Boiler Tubes

EA – A 192 Seamless Steel Boiler Tubes for High-Pressure Service

EA – A 209 Seamless Carbon-Molybdenum Alloy-Steel Boiler and Superheater Tubes

EA – A 213 Seamless Alloy-Steel Boiler and Superheater Tubes

EA – A 226 Electric-Resistance-Welded Steel Boiler and Superheater Tubes for High-Pressure Service

EA – A 249 Atomic-Hydrogen-Arc-Welded and Electric-Resistance-Welded Alloy-Steel Boiler and Superheater Tubes

EA – A 250 Electric-Resistance-Welded Carbon-Molybdenum Alloy-Steel Boiler and Superheater Tubes

Specifications for Still Tubes for Refinery Service

EA – A 161 Seamless Low-Carbon and Carbon-Molybdenum Steel Still Tubes for Refinery Service

EA – A 200 Seamless Intermediate Alloy-Steel Still Tubes for Refinery Service

Specifications for Heat-Exchanger and Condenser Tubes

EA – A 179 Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes

EA – A 199 Seamless Cold-Drawn Intermediate Alloy-Steel Heat-Exchanger and Condenser Tubes

EA – A 214 Electric-Resistance-Welded Steel Heat-Exchanger and Condenser Tubes

Specifications for Pipe

EA – A 120 Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses

EA – A 134 Electric-Fusion-Welded Steel Pipe (Sizes 30 in. and Over)

EA – A 135 Electric-Resistance-Welded Steel Pipe

EA – A 139 Electric-Fusion-Welded Steel Pipe (Sizes 8 in. to but not Including 30 in.)

EA – A 211 Spiral-Welded Steel or Iron Pipe

Specifications for Railroad Forgings and Electric Railway Wheels

EA – A 21 Carbon-Steel Axles for Cars and Tenders

EA – A 25a Wrought Steel Wheels for Electric Railway Service

EA – A 236 Carbon-Steel Forgings for Locomotives and Cars

EA – A 238 Alloy-Steel Forgings for Locomotives and Cars

Paints

EA – D 607 Specification for Mica Pigment

Petroleum Products

EA – D 524 Method of Test for Carbon Residue of Petroleum Products (Ramsbottom Carbon Residue)

Withdrawals of Emergency Alternate Provisions in Specifications for:

EA – B 158 Rope-Lay-Stranded and Bunch-Stranded Copper Cables for Electrical Conductors

EA – D 82 Basic Sulfate White Lead

EA – D 496 Chip Soap

EA – D 498 Powdered Soap (Nonalkaline Soap Powder)

from stock by the manufacturer or distributor. Processes of manufacture are covered; tests are to be in accordance with the materials specifications listed for Cupola Malleable Iron (A 195), or for Malleable Iron Castings (A 197), and finally marking requirements are given. This standard resulted from the prompt work of Committee A-7, which acted on a suggestion from the Conservation Division, WPB, that standardized requirements for these fittings would aid the substitution of malleable iron for copper in some valve parts, also substitution of iron valves for brass valves 2 in. or smaller. This shifting of material has been urged to conserve copper. The original request from the WPB was dated July 10; it can be seen that Committee A-7 moved promptly and efficiently.

Emergency Alternate Provisions

It will be noted that numerous emergency alternate provisions are published in this BULLETIN (page 51), many developed through the work of Committee A-1 on Steel, in cooperation with National Emergency Steel Specification work. The provisions in the specification for carbon-steel forgings locomotives and cars (EA – A 236) involves changes in chemistry to help out in connection with acid open-hearth steel; temporary elimination of residual alloy requirements for nickel and chromium; and the omission of carbon segregation test. Perhaps of most interest is the inclusion of two new classes of material, designated "H" and "I," providing quenched and tempered forgings with considerably higher physical properties than are now covered. Class H has minimum tensile strengths of 100,000 to 115,000 psi., with 16 to 18 per cent elongation in 2 in.; the class I tensile ranges are from 110,000 to 130,000 psi.; elongation from 16 to 13 per cent—these properties varying with the size classification. Standardized requirements for this material should help those railroads which might be handicapped by very slow deliveries of alloy steels or inability to procure alloy steel, and without these higher properties redesigning and rebalancing might be necessary.

The numerous provisions in the pipe and tubing specifications result primarily from extended meetings of subcommittees functioning as part of NESS Technical Advisory Committee on Tubular Products, T. G. Stitt, Chairman. The two groups primarily involved were headed by H. B. Oatley, The Superheater Co. (his section covering pressure tubing—boiler and superheater tubes, still and heat exchanger tubing), and a section on water main pipe, headed by Russell Barnard, American Rolling Mill Co. The principal objective of the tubing group was a considerably simplified list of alloys, and excellent success resulted from numerous meetings and the close cooperation of consumers and producers represented. Many of the emergency changes bring A.S.T.M. requirements on chemistry in line with the recommendations of the TAC.

The committee has reduced the percentages of a number of the critical elements to as low a figure as possible without getting into the fringe where creep data and related information are not sufficient to enable proper design with high temperature and pressure.

It will be apparent that other changes will simplify production processes, and in a number of cases requirements are clarified where material is used for specific purposes.

Mica Pigment.—Although the change provided by this emergency alternate would seem minor involving as it does a change only in the requirements for total residue retained on a No. 325 sieve from the regular value of 7.0 per cent to the emergency figure of 10 per cent, it is very important because mica producers are now permitted to use only domestic scrap for wet ground mica. Since this is not altogether suitable for wet grinding, it has become increasingly difficult to meet the 7.0 per cent maximum figure.

Withdrawal of Emergency Specification

It will be noted from the list that the emergency specification covering Standard Hardness Conversion Table for Cartridge Brass has been withdrawn. This was approved at the Annual Meeting as a regular A.S.T.M. standard with the designation E 33 – 42. In other words it has progressed from an emergency status to that of a regular specification.

REVISION OF EMERGENCY SPECIFICATIONS

The Emergency Specifications for Carbon-Chromium Ball and Roller Bearing Steels (ES – 5) approved some time ago but not set in type because revisions were anticipated have now been published with the designation ES – 5a (the letter "a" indicating modifications, much as in the case of the Federal specifications designations). These specifications incorporate the later changes approved which permit somewhat higher residuals of nickel and molybdenum and ease requirements on surface defects for ball wire and rods for cold heading. This specification was prepared originally in one of the National Emergency Specification groups under the joint sponsorship of S.A.E., A.I.S.I. and A.S.T.M. Three types of material are covered with specified chemical analysis, related requirements, and usages of the three types indicated, type A, for example, being applicable for ball, cylindrical roller, spherical roller, and rings.

New A.S.T.M. Publications

INTENSIVE WORK is under way on all of the books in the heavy printing schedule and wherever possible special compilations are being issued in advance of the 1942 Book of Standards, all three parts of which are expected for distribution in December. Several of the separate compilations of standards have already appeared, including those in the field of coal and coke (D-5); steel piping materials (A-1); electrical-heating and electrical-resistance alloys (B-4); petroleum products and lubricants (D-2); cement (C-1); and textile materials (D-13). All of these books are of a rather extensive nature, notably those sponsored by Committees D-2 on Petroleum Products and D-13 on Textile Materials, the latter including much pertinent data in addition to the specifications and tests.

Under separate cover there has been sent to each member a booklet entitled "A.S.T.M. Publications" and a Members' Order Blank which gives a brief description of the books, with the special prices to members.

Use of Filter Press in Preparing Samples for Soil Tests

By J. L. Byers[1]

For a number of years the Michigan State Highway Department has recognized the importance of the testing of soils in connection with all subgrades and stabilized surfaces. This makes it necessary for the laboratory to conduct tests on hundreds of samples each year, the primary tests being the determination of plasticity index and hydrometer analysis on material passing a No. 40 sieve.

In order to expedite the preparation of these samples, the laboratory has introduced the use of a modern filter press which replaces the dry sieving and the decantation methods. The major portion of the samples received are of processed gravel in which it is necessary to determine the grading and the plasticity index of the fine material present in order to control the amount of clay to be added. The washed solution resulting from the elutriation test on the gravel is immediately filtered through a pressure filter press, a working diagram of which is illustrated in Fig. 1. The bottom of this filter is equipped with a 10-mesh wire screen over which is placed a sheet of 10-oz. canvas which in turn is covered with a No. 230 filter paper.

After the solution is placed in the press it is allowed to stand for 4 or 5 min. to allow the coarser material to settle to the bottom and then the pressure is applied. This is necessary so that the high pressure (80 to 90 psi.) will not drive the fine material directly on the filter paper and thus retard the filtering time. The time for filtering will vary from about 20 min. to 1 hr. depending upon the amount and the grading of the fines and the amount of water used in the elutriation test.

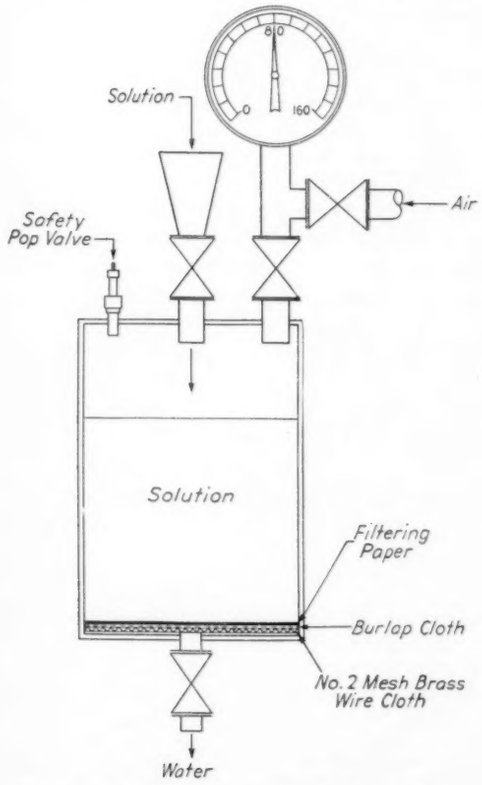


Fig. 1.—Schematic Drawing of Filter Press.

The material when removed from the filter press is just slightly damp so that the liquid limit and plastic limit tests may be conducted on this material without further drying. This shortens the time necessary for these tests considerably in that when using the decantation method it is necessary to allow the washed solution from the elutriation test to stand from 24 to 48 hr. for settling. In decanting or siphoning there is quite likely to be a loss of part of the extremely fine material which may affect the final results; also in this method if the temperatures used in drying the remaining fines are excessively high the physical properties of the material may be affected so that the test results will not be reliable.

A number of laboratories prepare their samples by dry sieving, but it is very questionable if all of the fines are obtained in this method. The test results on a comparison of a number of samples prepared by the decantation method *versus* the filter press have shown that the plastic limit is affected very slightly but that the liquid limit is affected in such a manner as to give a lower plastic index value when the sample is prepared by the decantation method.

As stated above, Fig. 1 shows the working diagram of

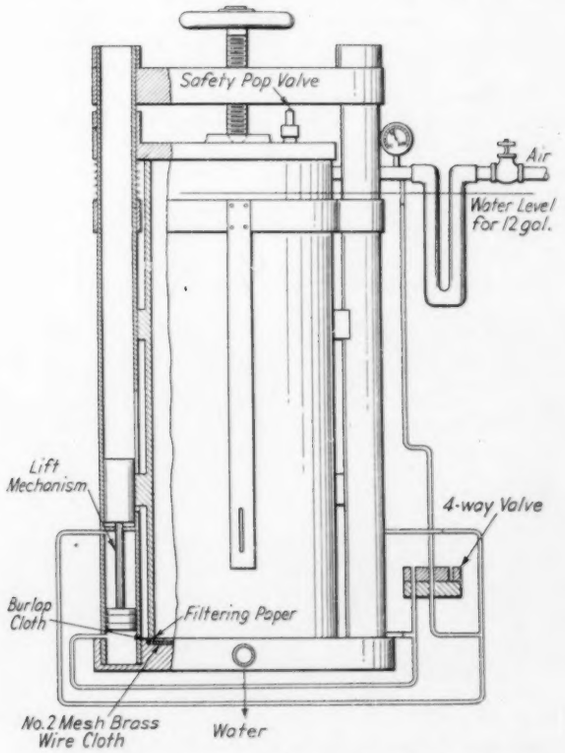


Fig. 2.—Filter Press Equipped with Air Lift.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia, Pa.

[1] Supervisor of Laboratory, State Highway Laboratory, Michigan State Highway Dept., University of Michigan, Ann Arbor, Mich.

the filter press. This press when received from the manufacturer was equipped with a yoke clamp for holding the top and cylinder in place during filtering. This necessitates releasing the clamp and removing the cylinder in order to obtain the filter cake, which is the sample.

Recently we have had a new filter press constructed, especially designed for this work (Fig. 2). The main feature of this new press is that the main cylinder is operated with an air lift, thereby eliminating the handling of the heavy parts when removing the filter fines. The air lift is operated from the same pressure line as the filter press and raises the main cylinder about 6 in., giving ample room to remove the fines and to properly place the filtering medium for a new sample.

The Electron Microscope and Its Uses

Additional Comments by R. Bowling Barnes and Charles J. Burton

Subsequent to the appearance of Messrs. Barnes and Burton's paper on "The Electron Microscope and Its Uses," in the May ASTM BULLETIN, No. 116, pages 34 to 41, the following material was submitted by the authors for inclusion in the reprints of their paper. It is being presented here for the benefit of those interested.

In column 2, p. 35, a brief discussion of the formulas for the limit of resolution of optical instruments was presented. For purposes of clarification, it seems advisable to offer at this time a further discussion of the origin of these formulas.

Lord Rayleigh proposed as an arbitrary criterion for resolution that two objects be considered resolved by an optical instrument when the first diffraction minimum in the image of one object exactly coincides with the central diffraction maximum in the image of the other. Therefore the images of two small objects which are just resolved by a lens are separated by a distance equal to the radius of the first diffraction ring, or, for example, the first dark ring which surrounds the image of a star. By making use of calculations which Airy had made in 1835 of the intensity distributions within such a diffraction pattern, it can be shown that this distance is given by

$$R = \frac{1.22\lambda F}{2r} = 0.61\,\frac{\lambda}{N.A.}$$

where

λ = the wave length of the light used,
F = the focal length of the lens,
r = the radius of the lens,
1.22 = a constant arising from the Bessel function used in integrating the intensity of light over the circular aperture of the lens, and
$N.A. = r/F$ = Numerical Aperture of the lens as defined by Abbé, when the refractive index between the object and the lens is equal to 1.0.

It has been further demonstrated that, for the case of a microscope, this same R represents the limit of resolution, that is, the minimum separation which two very small objects can have and still give rise to images which are resolved according to Rayleigh's criterion.

Abbé performed a classical set of experiments with the optical microscope using a diffraction grating for his object. His results proved that the structure of such a grating can be resolved only if the objective is of such dimensions as to include simultaneously the central image and one of the first order diffraction spectra produced by the grating. By combining the equation governing the production of spectra by a grating, with the relationships used in geometrical optics to show the image-forming properties of a lens, Abbé concluded that a small grating space R could just be resolved if the incident light upon the grating was parallel, when

$$R = \frac{\lambda'}{\sin\theta} = \frac{\lambda}{\mu\sin\theta} = \frac{\lambda F}{\mu r} = \frac{\lambda}{N.A.}$$

where

λ' = wave length of light in a medium of refractive index = 1,
λ = wave length of light in a medium of refractive index = μ,
μ = refractive index of the medium between the grating and the lens, and

$$\mu\sin\theta = \mu\left(\frac{\text{radius of lens}}{\text{focal length of lens}}\right) = \text{Numerical Aperture.}$$

In actual practice a condenser lens is used as part of the illuminating system, and so the incident light is far from parallel. Abbé showed that for completely oblique light a factor of 2 should be introduced into the denominator of the above equation. We can therefore for the average case write Abbé's formula for the limit of resolution as

$$R = 0.5\,\frac{\lambda}{N.A.}$$

The theoretical limit of resolution of an optical microscope can then be expressed generally as

$$R = K\,\frac{\lambda}{N.A.}$$

where the constant K has the values

$K_{\text{Rayleigh}} = 0.61$
$K_{\text{Abbé}} = 1.0$ (axial) $\rightarrow$ 0.5 (oblique)

Although very nearly equivalent, these two equations were arrived at by entirely different lines of reasoning and should not be confused.

A Cotton Fiber Strength Tester[1]

By E. H. Pressley[2]

SYNOPSIS

The object of the work described in this paper was to devise a method of determining quickly and accurately the relative strength of the lint of cotton selections made in carrying out the breeding program of the department, and to construct a simple piece of laboratory apparatus upon which such determinations can be made.

A part of the experimental work done so far was for the purpose of determining the amount of variation that may be expected within individual samples of various kinds, such as those from commercial bales and from single plants. The results from some samples were found to vary much more than those from others due probably to the method of ginning. Highly significant differences were found between plants of individual progeny rows, while the lint of some varieties was found to be practically twice as strong as that of others.

Comparisons were made between the results obtained from 24 samples by this method and those obtained from the same samples by the improved Chandler method in which the two sets of results agreed very closely in regard to relative strength. The results from a series of tests made at intervals of one or more months were quite uniform.

The fact that tests can be made very rapidly should make the machine particularly useful to cotton breeders as well as to others interested in relative strength. Proper use of a sample whose strength in thousands of pounds per square inch is known should enable the operator to translate all his results into these terms.

REALIZING THE need of some simpler and faster means of determining the strength of lint than that now in common use, a method was decided upon that seemed to offer some possibilities, and experimental work was begun in 1939 on a machine for use in making such determinations. With the aid of an expert mechanic, this machine has now been completed, and has been used sufficiently to give some idea of its worth to cotton breeders (Fig. 1).

During the construction of the machine and the working out of a technique for handling it, speed as well as accuracy has been foremost in mind at all times. To be of the greatest value, any system and machine devised must enable the operator to make more determinations in a given length of time than can be made by present methods.

A scale of the beam type was constructed to determine the number of pounds required to break a ribbon of fibers such as is used in determining staple length, or such as the cotton breeder breaks by hand when trying to determine fiber strength of selections. Since it is impossible to get a sample or ribbon containing the same number of fibers each time, or to count the number of fibers in such a sample, the only alternative is to use the same length of fibers, and to determine the amount in each sample by weighing after the fibers are broken.

An index of comparative strength can then be obtained by dividing the number of pounds required to break the sample by the weight of the broken fibers. The figure obtained is in reality the number of pounds required to break a milligram of cotton of a standard length of approximately 0.460 in. This figure has varied from as low as 5.72 lb. for weak fiber to as high as 10.50 lb. for strong Sea Islands.

It is realized that laboratories have been set up for testing other characters of cotton in addition to its tensile strength, and that charges for these services are relatively low. However, it is doubtful that anyone will be able to have all needed tests made in these laboratories. In addition to the expense involved, there is the time element which is often of more importance. The speed with which individual ribbons can be tested makes the use of this machine possible by anyone regardless of whether an air-conditioned laboratory is available or not. With combed bundles prepared in advance, 45 samples have been tested in a day. Five ribbons from each sample were broken and combined into one for weighing, thus making a total of 225 test specimens or breaks.

The fact should be kept in mind that our purpose in the beginning was to build a machine with which we could determine the relative strength of our own cotton selections. Since this involves anywhere from 1000 to 3000 samples per year, the greatest possible speed that could be attained was highly essential. An attachment on the machine to move the weight outward at a constant rate of speed would possibly give more accurate results, but would add something to the time required for testing each ribbon.

Difficulties Encountered

Considerable trouble has been encountered in constructing clamps that will give comparable results on the same sample of cotton. This problem has not yet been com-

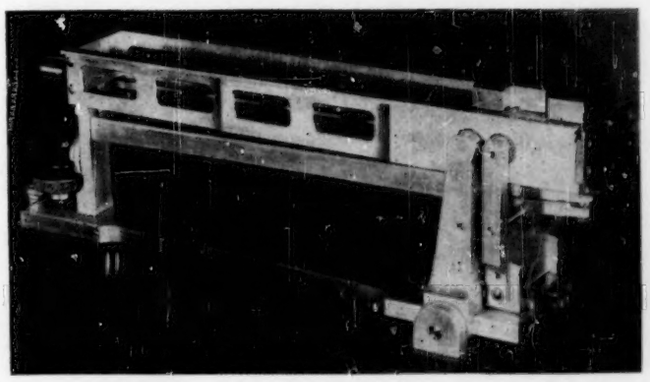


Fig. 1.—Machine for Testing Strength of Cotton Fibers Showing Some of the Details of Construction.
The clamps holding the fibers are shown inserted at the right just above the base.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia, Pa.

[1] Prepared for presentation before a meeting of the Raw Cotton Subcommittee, Committee D-13 on Textiles, American Society for Testing Materials, at Providence, R. I., March 11, 1942. Read by M. E. Campbell.

[2] Professor of Plant Breeding, University of Arizona, Tucson, Ariz.

pletely solved, and further experiments are being conducted along this line.

To make possible the testing of the shorter stapled varieties, the combined thickness of the clamps must be kept at a minimum. This means that each individual clamp must be made from material not over 1/4 in. in thickness. This in turn makes necessary the use of very small screws, pins, etc. In some instances these have been broken in an effort to apply sufficient pressure to the ribbon to prevent slippage of individual fibers. The practice of using very narrow ribbons placed in the same position in the clamps each time is not recommended, since this will soon form a depression in the leather holding surface. The ribbons should be made as wide and thin as possible, and should be shifted about on the holding surface to prevent the formation of such depressions. The same set of clamps has been used in our work for more than two years, and although thousands of ribbons have been broken during this time, the leathers in the clamps have been changed only once.

The fact that different clamps do not always give the same results on a given sample of cotton does not decrease the usefulness of the machine and method for anyone wishing to know the comparative strengths of various samples. This is particularly true in the case of cotton breeders who wish to know the comparative strength of their selections so that those having weak fiber may be discarded. Two sets of clamps that give results differing considerably on a given sample of cotton will still rank a series of samples in the same relative order of strength. The strong samples will be shown to be strong and the weak ones weak regardless of the actual indexes obtained.

Technique and Terms Used

The technique used in operating the machine is quite simple and can soon be mastered by anyone accustomed to handling cotton fibers. The ribbons to be broken should of course, be as nearly representative of the original sample as can possibly be obtained. The standard method used in preparing bundles for the Chandler strength test is recommended for the preparation of bundles from which the ribbons are to be drawn.[3]

A ribbon of proper size is drawn from the prepared bundle and passed through a fine comb a sufficient number of times to remove all neps, trash, and short fibers. It is then placed in the clamps, the clamps closed, and sufficient pressure applied by means of set screws to prevent slippage. The size of the ribbon used and the amount of pressure necessary will have to be learned from experience. The ends of the fibers are then cut off against the sides of the clamps with a knife. The clamps are next placed in the machine and the ribbon broken. The number of pounds required to break the ribbon are then read from the scale on the beam and recorded. The clamps are then removed and the broken fibers recovered for weighing. This weight divided into the number of pounds read from the beam gives the strength index of the ribbon or sample tested. All of these operations together require only a few minutes for each ribbon tested.

[3] Howard B. Richardson, T. L. W. Bailey, Jr., and Carl M. Conrad, "Methods for the Measurement of Certain Character Properties of Raw Cotton," *Technical Bulletin No. 545*, U. S. Department of Agriculture, pp. 7-9 (1937).

Explanation of Terms

The term strength index has already been defined. The broken fibers of a single ribbon may be referred to as a single-break sample or as a single break. Ten ribbons broken, weighed, and calculated separately may be referred to as ten single-break samples or as ten single breaks. The fibers of two or more ribbons when combined and weighed at one time and this weight divided into the total number of pounds required to break them may be referred to as a two, three, four, five, or ten-break sample.

Experimental Results

In order to determine the range of indexes and the type of distribution that might be expected, a commercial sample of locally grown cotton was obtained from which 510 individual ribbons were broken, weighed, and the strength index of each calculated. Indexes obtained varied from 5.33 to 6.12, inclusive, with a mean of 5.724 and a standard deviation of 0.124 lb.

The indexes of pairs of successive breaks were then averaged and the distribution determined for the 255 resulting samples. In this case indexes were obtained that varied from 5.48 to 5.97, inclusive, with a mean of 5.725 and a standard deviation of 0.091 lb. In the same manner samples were made up by averaging the indexes of three, four, five, and ten successive single-break, samples. The standard deviations of these distributions were 0.071, 0.064, 0.064, and 0.047 lb., respectively.

The bale from which the commercial sample discussed above was taken was ginned on a commercial gin of six stands. A sample taken from such a bale should be as nearly representative of the entire lot of lint as it is possible to obtain due to the mixing of the seed cotton by the cleaning machinery and to the further mixing of the lint as it comes from such a large number of saws. In the laboratory the seed cotton from individual plant selections is ginned on a small roller gin which has very little mixing effect upon the seed cotton and lint. Under the same ginning conditions less variation should be obtained from the lint of individual plants than from a commercial bale. Due probably to the fact that the roller gin does not mix the lint as does the saw gin, greater instead of less variation has been found.

During the time the machine has been in operation, large numbers of ribbons have been tested from several different plants in studying the accuracy attained in the use of the machine as well as variations caused by sampling, and changes in humidity and temperature. Since these results cannot be discussed individually they are given in tabular form (Table I).

All of the distributions were rather wide, particularly so in the case of plant No. 4. One possible reason for these wide distributions and consequent high standard deviations, in addition to that of inadequately mixed samples was the change in temperature and humidity that occurred in the laboratory during the course of the day. A total of 100 samples from plant No. 4, consisting of a ribbon from each of 20 combed bundles broken between the hours of 8:15 and 9:30 a.m on five consecutive days, gave a mean index 0.255 lb. higher than another 100 samples drawn from the same bundles on the same days between the hours of 1:15 and 2:30 p.m. This difference is more than sixteen times its error. One hundred ribbons from

TABLE I.

Type of Sample	Number of Samples Used	Number of Breaks per Sample	Mean, lb.	Standard Deviation, lb.	Range, lb.	
					At 5 per cent Level SDX4	At 1 per cent Level SDX6
Commercial	510	1	5.724 ± 0.004	0.124 ± 0.003	0.496	0.744
	102	5	5.722 ± 0.004	0.064 ± 0.003	0.256	0.384
	51	10	5.722 ± 0.004	0.047 ± 0.003	0.188	0.282
Single plant No. 1	500	1	6.229 ± 0.005	0.149 ± 0.003	0.596	0.894
	100	5	6.228 ± 0.007	0.097 ± 0.005	0.388	0.582
	50	10	6.228 ± 0.008	0.079 ± 0.005	0.316	0.474
Single plant No. 2	500	1	7.192 ± 0.005	0.167 ± 0.004	0.668	1.002
	100	5	7.190 ± 0.007	0.106 ± 0.005	0.424	0.638
	50	10	7.187 ± 0.009	0.094 ± 0.006	0.376	0.564
Single plant No. 3	600	1	6.123 ± 0.004	0.162 ± 0.003	0.648	0.972
	120	5	6.123 ± 0.005	0.079 ± 0.003	0.316	0.474
	60	10	6.123 ± 0.006	0.065 ± 0.004	0.260	0.390
Single plant No. 4	600	1	6.214 ± 0.005	0.178 ± 0.003	0.712	1.068
	120	5	6.215 ± 0.008	0.136 ± 0.006	0.544	0.816
	60	10	6.211 ± 0.010	0.113 ± 0.007	0.452	0.678
Single plant No. 4*†	120*	5	6.217 ± 0.005	0.080 ± 0.003	0.320	0.480
	60*	10	6.214 ± 0.006	0.068 ± 0.004	0.272	0.408
	60†	10	6.216 ± 0.004	0.042 ± 0.003	0.168	0.252

* Indexes of 5 and 10 individual breaks averaged so as to partially eliminate the effect of daily periods.
† Indexes of 10 individual breaks averaged so as to eliminate the effect of bundles, days and daily periods.

plant No. 3 handled in exactly the same manner gave a mean 0.207 lb. higher when broken between the hours of 8:00 and 9:20 a.m. than did another lot of 100 ribbons from the same bundles broken between the hours of 4:00 and 5:20 p.m. In this case the difference between the means was more than eleven times its error. At the same time the difference between the standard deviations was less than its error. During the five days over which the tests lasted the temperature did not vary more than 2.5 deg. while the relative humidity did not vary more than 2.2 per cent for the periods concerned.

Samples were broken throughout the day when the tests were made, and indexes determined in the morning fell largely toward the upper end of the distribution while those determined in the afternoon fell toward the lower end. The tests consisting of five and ten breaks shown in the first five sections of Table I were made up in each case by taking the average of five and ten consecutive single breaks, respectively. When tests consisting of five breaks were made up in a manner to eliminate as far as possible the effects of time of day, much more uniform results were obtained. In the case of plant No. 4 the standard deviation for samples of this size was reduced from 0.136 to 0.080 lb., while the range at the 1 per cent level was reduced from 0.816 to 0.480 lb. When samples consisting of ten breaks were made up by averaging ten individual indexes in such a manner as to eliminate the effects of bundles, days, and daily periods, the standard deviation was reduced from 0.113 to 0.042 lb., while the range at the 1 per cent level was reduced from 0.678 to 0.252 lb.

The lowest index obtained from any sample tested sufficiently to give accurate results was that of 5.72 obtained from the commercial sample previously discussed. The highest index obtained was one of 10.53 from a sample of Southern grown Sea Island. There is a difference of 4.81 lb. between these indexes. Assuming an accuracy no greater than that obtained from plant No. 4, it would still be possible with a single break to place a sample of cotton in one of five different strength classes ninety-nine times out of a hundred. Results from single breaks as uniform as those obtained from the commercial sample would permit the placing of lots of cotton in at least seven strength classes with the same degree of accuracy. Five single breaks would permit location in twelve strength classes, while ten single breaks would permit location in eighteen strength classes within this already observed range. A single break can be made in 2 min., while ten single breaks can be made in a proportionate length of time, or 20 min., when the fibers of each ribbon are weighed and the results calculated separately. Combining the ten ribbons and weighing as one will save considerable time and give practically the same results.

Comparison of Results Obtained with Those Obtained by the Improved Chandler Method

We have had only one opportunity to test samples on our machine that have been tested by another method. Through the courtesy of what is now known as the Agricultural Marketing Administration of the U. S. Department of Agriculture, the laboratory was furnished with 24 samples of lint upon which that agency had made extensive tests including tensile strength by the improved Chandler method. These samples were identified by key numbers only, with no information given as to strength, variety, or staple length.

A bundle of combed fibers was prepared from each of the 24 samples before testing began. Ribbons from these bundles were broken in rotation to overcome differences due to varying conditions in the laboratory. Weighing of the individual ribbons was done after one from each bundle had been broken. When five ribbons from each bundle had been broken, they were combined and weighed as a single sample. This procedure was followed until three sets of five-break samples had been obtained. The mean of these three five-break samples was taken as the strength index.

The results of these tests were then sent to the Agricultural Marketing Administration for comparison with results already obtained by the Chandler method. Eight of the 24 samples were given the same relative rank as to strength by the two machines. Twelve samples differed by one position in rank while the remaining four samples differed by two positions. The samples ranged in tensile strength from 65,700 to 102,800 psi. by the Chandler method, and from a strength index of 5.58 to one of 9.12 lb. by our method. In this test 1000 psi. was equivalent to approximately 0.092 lb. on our scale.

The coefficient of correlation between the results secured from the two machines was 0.971 ± 0.008. Coefficients of correlation were also calculated between the Chandler re-

sults and those from each of the three five-break samples. These coefficients varied from 0.963 to 0.973.

Comparison of Results of Different Tests on the Same Samples

It should be of interest to mention the uniformity of the results from the three five-break tests. Ten of the samples were given the same relative position as to strength by each of the three tests. Nine samples differed by one position, four by two positions, and one by three positions. With one exception all changes of more than one position took place between six varieties whose indexes fell between 7.48 and 7.80 lb., inclusive. Coefficients of correlation between the results from the five-break samples themselves varied from 0.992 to 0.996.

The statement was previously made that considerable time may be saved by combining all ribbons broken from a given sample for weighing at one time. In the above tests both methods were used. The coefficients of correlation between the results obtained by taking the mean of the indexes of five ribbons weighed individually and those obtained by combining the same five ribbons for weighing as one varied from 0.9988 to 0.9992.

Due to the nature of our laboratory work we have not had time to recheck many samples at intervals throughout the year. Only one sample has been tested sufficiently in this manner to make the results worth reporting. In March, 1941, several samples were tested for a commercial cotton breeder. Among these was one strong sample which had an index of 9.33 obtained from breaking 15 ribbons. On three subsequent dates further tests were made for this breeder. On each occasion the sample mentioned above was tested again as a check with the following results: 9.31 in June, 9.32 in September, and 9.28 in November. In each case 15 ribbons were broken in rotation with ribbons from the other samples being tested with the exception of the one in June when two sets of 15 each were broken. The individual indexes for these two sets were 9.31 and 9.32.

As a further check on what may be expected from the machine, another test was made on this sample in February, 1942. Two sets of 15 ribbons were again broken with the following results: one set broken in the morning gave a strength index of 9.39. Another broken in the afternoon of the same day gave an index of 9.27. Seven tests consisting of 15 breaks each were thus made on this sample in a year's time. The mean of the seven tests was 9.32 lb. In no case did a single test consisting of 15 breaks vary from this mean by more than 0.07 lb., while the difference between the highest and lowest indexes obtained was 0.12 lb. This 0.12 lb. is just one-fortieth of the observed range of 4.81 lb. between the weakest and strongest samples tested.

Standardization of Results

The matter of comparing results obtained by different operators on different machines and in different laboratories should be given some consideration here. It is very doubtful whether comparisons can be made satisfactorily without some sort of check being used by each operator. This has been brought very forcibly to our attention within the past few months. A machine which was being used in a laboratory in another state and which was thought to be giving results entirely too low was returned for checking. A sample of cotton which gave an index of 8.19 in this other laboratory gave one of 10.08 when tested in our laboratory. Nothing had been done to the machine and clamps in the meantime. A combed bundle of fibers from the same original sample was used in each test. The only difference between the two tests was that they were made by different operators in different laboratories. Differences in laboratory conditions were probably of much greater importance than that of operators.

The facts cited above lead to the question of the establishment of some method of checking whereby results obtained in one laboratory may be made comparable with those obtained in others. It is also desirable for each individual laboratory to be able to compare one year's results with those of other years. Changes in results due to changes in laboratory conditions, as well as those which may occur if it becomes necessary to change clamps, may be sufficient to cover up or to greatly accentuate differences in the cotton itself. Due to the fact that many people may become interested in the strength of a sample of cotton other than the one who tests it, the suggestion is made that anyone using a machine of this type secure a sample of cotton of known strength to be used as a check when testing his own samples. This should permit cotton breeders as well as others interested to determine very accurately the strength of their samples even when no conditioned laboratory is available. The speed with which tests can be made will enable the operator to take full advantage of the use of a sample of known strength.

In the light of our experience the best method to follow would be to prepare combed bundles in advance from as many samples as can be handled in a day. A combed bundle from the sample of known strength should be included with each ten to fifteen that are to be tested. Ribbons from these combed bundles should then be broken alternately throughout the day until the desired number of each has been broken. These may be weighed individually after each series has been finished, or all from a given sample combined and weighed at one time.

A few pounds of cotton of known strength would be sufficient to check a large number of samples due to the fact that individual ribbons are quite small. In well-conditioned laboratories fewer checks would be necessary—one a day or even one or two a week might be sufficient. Without such air conditioning, checks should be run with each batch of samples tested. It might be desirable to have several standards varying considerably in tensile strength so that comparisons can always be made between samples of approximately the same strength.

It goes without saying that any sample used as a standard should be tested thoroughly and under the most uniform conditions possible. From our own experience it would seem advisable to have all such samples tested in one laboratory on one machine by one operator, and to have the tests run over a period of several days with individual tests made at different times in the day. It would not be necessary for all standard samples to be of the same strength so long as the strength of each sample was definitely known.

This leads to the possibility or advisability of setting up some form of laboratory strength standards. It would seem advisable for each user of a machine of this type to

have a few samples of his cotton tested in the best laboratory available, or that some such laboratory prepare samples for sale at a stated price to anyone interested.

In view of the fact that the figures making up the strength index have very little meaning other than in a relative sense, it is probably desirable to translate the indexes into terms that are better understood. Since expressing tensile strength in terms of thousands of pounds per square inch is already a matter of common practice, and since this term is understood by all connected with the cotton trade, it may be well worth while for each individual using this machine to change his results into this unit. To do this it will be necessary to use check samples whose strength in these terms has been carefully determined under standard conditions. By breaking ribbons from the standard in rotation with those of other samples being tested, the value of a thousand pounds per square inch in terms of the strength index can be determined. This value can then be used as a factor in translating into the unit of the standard the strength indexes of the other samples tested at the same time.

It is quite evident that this factor will change from time to time in any laboratory not properly conditioned, and that it should be determined by each operator under his own particular conditions and technique. This emphasizes again the need of standard samples carefully tested and available to anyone interested. Confusion as to the manner in which determinations were made could easily be avoided by following the tensile strength with the name of the machine upon which the tests were made. For instance, a tensile strength of 100,000 psi. determined on the Chandler machine could be designated as 100,000 psi. Chandler.

Summary and Conclusions

This machine offers a quick and easy means of determining the relative strength of cotton fibers which should prove particularly helpful to cotton breeders and others. The speed with which it can be operated makes its use effective even where no conditioned laboratory is available. A sample whose strength in thousands of pounds per square inch is known should be tested in rotation with all samples whose relative strength is being determined so that allowances can be made for changes in laboratory conditions, etc. In this way the results obtained by any given operator under his particular conditions may be made comparable with those obtained by others.

Dudley Medal and Thompson Award

Recognition of one of the relatively newer phases of A.S.T.M. work was made at the Annual Meeting in the award to Messrs. F. C. Todd and A. W. Gauger of the Charles B. Dudley Medal. This was made in recognition of their outstanding paper at the 1941 Annual Meeting dealing with "Studies on Measurement of Water Vapor in Gases." Mr. Todd, Assistant Professor of Gas Engineering at Penn State College (now on the staff of Battelle Memorial Institute) and Dr. Gauger, who is Director of Mineral Industries Research, carried out very extensive work in an effort to develop satisfactory standard tests. Moisture content of fuel gas is extremely important, since control of corrosion, prevention of ice formation, and other factors depend on the amount of moisture present.

The laboratory method they developed depends on the absorption of light by water vapor at a particular wavelength in the near infrared. This involved the building of sensitive equipment to make the various measurements.

The field method is based on the change of color of the chemical cobaltous bromide in an organic solvent on the addition of water.

Mr. Todd is a graduate of Oklahoma Agricultural and Mining College, with a Ph.D. in Physics; he was associated with Westinghouse for a number of years and had been at Penn State since 1937.

Dr. Gauger received his A.B. degree from the University of Minnesota, and his Ph.D. from Princeton University, where he was a Fellow. He was chemist for the Great Western Sugar Co. and other companies and for several years was Director of the Division of Mines and Mining Experiments at the University of North Dakota. He has been at Penn State since 1931.

In receiving the award, Dr. Gauger referred to the work of A.S.T.M. Committee D-3 on Gaseous Fuels, of which he is chairman, crediting the committee with close cooperation in the activities.

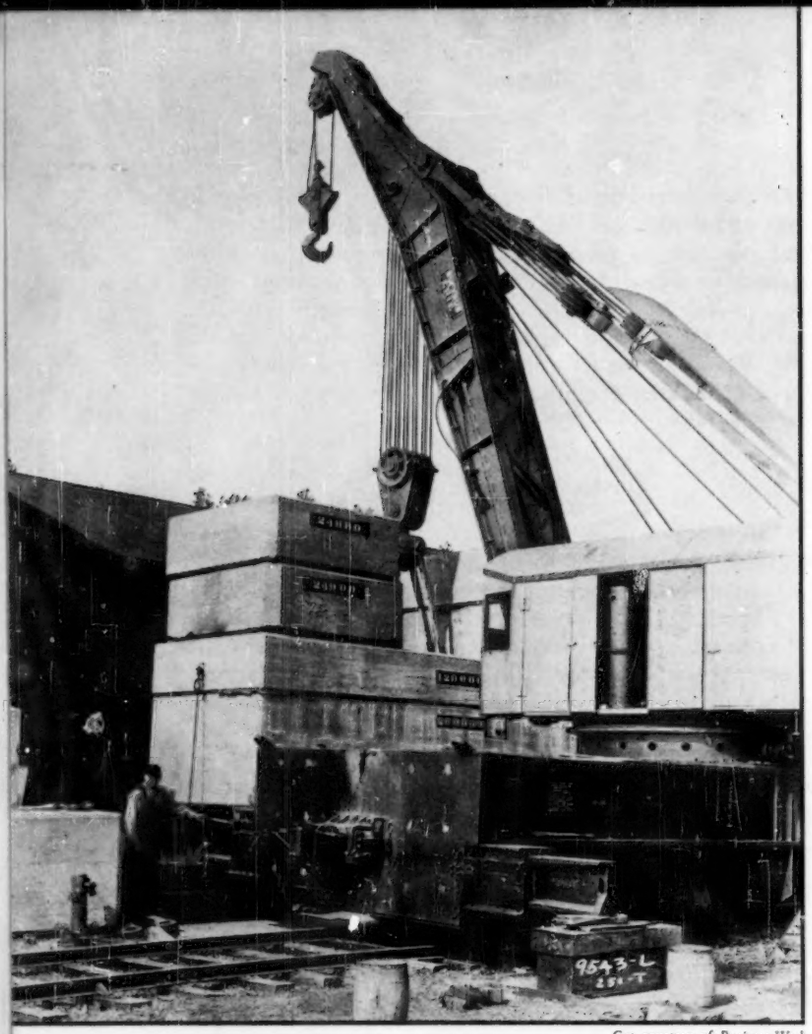
Dudley Medalists—Messrs. Todd (left) and Gauger

Sanford E. Thompson Award

This award, sponsored by Committee C-9 on Concrete and Concrete Aggregates, was made to John Tucker, Jr., Chief, Concreting Materials Section, National Bureau of Standards, for his 1941 paper on "Statistical Theory of the Effect of Dimensions and of Method of Loading Upon the Modulus of Rupture of Beams."

Mr. Tucker's paper shows how the variations in the strength of small elements of volume within a specimen will affect the modulus of rupture of beams of different dimensions and beams subjected to different loading. For example, the modulus of rupture of a beam will be decreased with beam length and with beam depth and will be greater in centrally loaded beams than in similar beams loaded at third points.

A discusser of this paper indicated that it had three important practical contributions: first, the necessity of standardization of test methods is demonstrated once again; second, the necessity of reporting some information as to the variability of test results is exemplified; finally, another step has been taken in the clarification of our thinking with regard to the strength of a material.



Cut courtesy of *Business Week*

Use of A.S.T.M. Standards

THE ACCOMPANYING illustration shows an extremely powerful railway crane built by the Bucyrus-Erie Co., for the Denver & Rio Grande Western Railroad. In the test before final approval it lifted 479,540 lb. of concrete (the crane is designed for 250-ton capacity with a 17½-ft. radius). This crane is an interesting example of the use of A.S.T.M. specifications. On inquiry it was found that a number of A.S.T.M. standards were used in connection with its construction, including the following:

A 7—Steel for Bridges and Buildings
A 30—Flange Quality Steel
A 63—Heat-Treated Alloy Steel Forgings
A 87—Steel Castings for Railroads
A 148—Alloy Steel Structural Castings

The Bucyrus-Erie Co. makes extensive use of A.S.T.M. specifications. R. C. Woodward, Chief Metallurgist, represents his company in A.S.T.M. Ray McBrian, Chemist, is the representative of the Denver & Rio Grande Western Railroad's membership in the Society.

1942 Welding Handbook

PREPARED THROUGH the cooperative work of a large number of authorities under the direction of a Handbook Committee, of which William Spraragen is editor, this latest Welding Handbook of the American Welding Society covers in detail practically every phase of this important subject. With the growing importance of welding as a war production and industrial tool in the construction of ships, tanks, planes, guns, ammunition, and machinery, this Handbook will meet a wide-spread need for general up-to-date information in concise form on the subject of welding. In order best to serve its purpose the volume has been prepared to cover, first, the physics and metallurgy of welding and the weldability of steels; second, the welding and allied processes; third, the materials used; fourth, training, inspection, and safety; fifth, design considerations and testing of welding; and sixth, the applications of welding.

While the text is arranged in handbook style, the material has been arranged in a logical sequence with enough explanatory matter so that it may be used as a textbook in engineering schools and as a reference book in trade schools. The primary purpose, however, is to give engineers an authoritative up-to-date reference book on the technical phases of welding.

Following the 124-page section dealing with Fundamentals of welding there is a 430-page section on welding processes, arc, atomic hydrogen, fundamentals of resistance welding, electrodes, electrode holders and conductors for resistance-welding machines, and a section on thermit welding. Allied processes such as brazing, surfacing, and metal cutting are treated in another section of 150 pages; there is detailed discussion of various metals subject to welding; also specifications for filler metal.

Training and inspection are discussed, and the concluding pages cover design considerations and applications. The important welding symbols are detailed. A comprehensive index is a valuable part of the publication.

In substantial cloth binding, page size 6 by 9 in., this 1605-page book can be obtained from the American Welding Society, 33 W. 39th St., New York, N. Y., at $6.00 per copy.

Highway Research Board Proceedings

RECENTLY published is the twenty-first volume of the Proceedings of the Highway Research Board, aggregating about 600 pages and including a number of technical contributions by leading authors. The various reports and papers are classified into the fields of economics, design, materials and construction, and maintenance. Many of the contributors are active in A.S.T.M. work. Under materials and construction are papers on testing and investigation of traffic paint, temperature and moisture variations in concrete pavement, vibration in concrete placement, soundness tests of aggregates, and effects of calcium chloride on cements and concrete. A copy of this cloth-bound publication can be obtained from the Highway Research Board, National Research Council, 2101 Constitution Avenue, Washington, D. C., at $3.25.

Also released is the book on Roadside Development aggregating about 200 pages and available at $1.

Believe It or Not

The paper presented at the last annual meeting to appear in the 1942 *Proceedings* dealing with analysis of uranyl oxalate actinometer includes in the section discussing spectro energy distribution of light sources a statement that "the data for sunlight are those proposed by Moon" (in this case the Moon being Mr. Parry Moon).

Stress-Strain Relations in Timber Beams (Douglas Fir)[1]

By Albert G. H. Dietz[2]

SYNOPSIS

This research was undertaken to determine the reasons for the differences in behavior of wood, with reference particularly to Douglas fir, in bending and direct stress. Two theories, Bach-Baumann and Newlin-Trayer, are investigated as a consequence. Five beams of edge-grained Douglas fir, three at 9 per cent moisture content and two at 24 per cent, were tested, as were direct tension and direct compression specimens cut from the beams.

Measurements were made by electrical-resistance-wire gages cemented to the sides of the test specimens.

The strain-distribution in beams is found to be a curve, rather than linear from top to bottom, even well below the proportional limit. All fibers, however, exhibit linear stress-strain characteristics until the bending proportional limit (well above the direct compression proportional limit) is reached, beyond which all exhibit marked hysteresis. The general features of the Newlin-Trayer theory are confirmed. Theoretical curves of strain-variation, closely following the observed variations, are deduced. An explanation is offered for the lower modulus of rupture observed in deep beams as compared with shallow beams.

Introduction and Theory

Wood possesses different ultimate strengths in compression, tension, and bending in the direction of the grain. It is weakest in compression, strongest in tension, and intermediate in bending. Moreover, the proportional limit in compression is appreciably lower than in bending, which in turn is generally considered to be lower than in tension although the tensile properties of wood have been little studied. Furthermore, wood low in moisture content exhibits higher ultimate strengths and higher proportional limits in both compression and bending than does wood high in moisture (*1*).[3] Tensile properties are considered to be less affected.

These observed differences seem to indicate that the usual assumptions respecting beams of *iso*tropic materials do not apply to wood. The modulus of rupture as calculated by the usual beam formula:

$$f_u = \frac{M_u c}{I} \qquad (1)$$

appears to have doubtful meaning since it assumes a straight-line stress change from maximum compression to maximum tension, which in turn indicates a much higher compressive stress sustained by the outermost compressive fiber in a beam in bending than is sustained by the fibers of a short block in axial compression. Also, if the straight-line relationship holds true, the outermost compressive fiber in a beam possesses a much higher proportional limit than does a similar fiber in a block subjected to axial compression. Whether cross-sections plane before bending remain plane after bending seems open to question.

A further peculiarity in the behavior of wooden beams is not explained by the usual beam theory. It is known that if two rectangular beams, one shallow and one deep, of the same species, density, growth characteristics, and moisture content, are tested under identical conditions, the shallow beam exhibits a higher modulus of rupture than does the deep one (*2*).

Two principal theories have been advanced to account for these discrepancies among compressive, tensile, and bending properties of wood.

Bach-Baumann Theory:

The older theory, advanced by Bach and Baumann (*3*), explains the bending behavior of a rectangular wooden beam by considering the stress-strain curves in direct tension and direct compression. If these curves are as shown in Fig. 1, they can be replotted as in Fig. 2, with the compression curve on one side of the horizontal axis and tension in the diagonally opposite quadrant. If, under the action of an external bending moment, the stress in the outermost compressive fiber is equal to some value *A-A* below the proportional limit, the corresponding stress in the outermost tensile fiber is *A'-A'*, the value *A'-A'* being such that the triangular areas *AOA* and *A'OA'* are equal. If the total depth of the beam is represented by the distance *A-A'*, the stress distribution is represented by the two triangles; the neutral axis is *A-O* distant from the

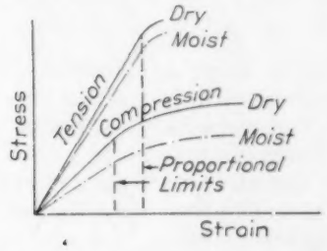


Fig. 1.—Tension and Compression Stress-Strain Curves for High and Low Moisture Content Wood.

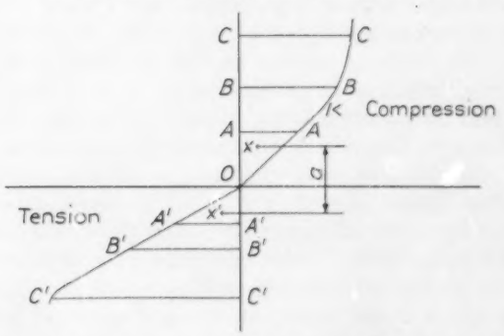


Fig. 2.—Tension and Compression Stress-Strain Curves Plotted in Accordance with Bach-Baumann Theory.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia, Pa.

[1] Material in this paper is taken from a thesis presented in May, 1941, for the degree of Doctor of Science from the Massachusetts Institute of Technology.

Presented at the forty-fifth Annual Meeting, Am. Soc. Testing Mats., Atlantic City, N. J., June 22–26, 1942.

[2] Assistant Professor, Department of Building Engineering and Construction, Massachusetts Institute of Technology, Cambridge, Mass.

[3] The italic numbers in parentheses refer to the reports and papers appearing in the list of references appended to this paper.

outermost compressive fiber; resultant compression and resultant tension are equal to their respective triangular stress areas multiplied by the breadth of the beam; the resultants act at the centers of gravity x and x' of the respective triangles; and the internal moment arm is equal to the distance a between the centers of gravity. Finally, the internal resisting moment must equal the external bending moment.

The same general considerations hold when the ultimate compressive fiber passes the proportional limit, as at *B-B*, although the outermost tensile fiber may be at a stress *B'-B'* below the proportional limit. Finally, the procedure still holds when outermost compressive and outermost tensile fibers have both passed their proportional limits, and beam failure occurs when either outermost fiber reaches its ultimate strength.

A number of phenomena are explained. Provided the stress-strain curves are as shown, the suspected shift of the neutral axis toward the tension side is a logical consequence. With this shift comes a relative decrease of stress in the compression fibers and a corresponding increase in the tension fibers. This automatically explains the increased modulus of rupture. Depending upon the shapes of the direct tension and compression stress-strain curves and their ultimate values, failure may occur first on either the tension or compression side of the beam. Since the ultimate strength of moist wood is less than that of dry, the modulus of rupture is correspondingly lower. The increase in proportional limit in bending over that in direct compression can also be explained, although less convincingly, if the slope of the direct tensile curve (tensile modulus of elasticity) is sufficiently greater than that of direct compression to throw the neutral axis well below the center of depth, in which case the stress *A-A* does not reach the point of curvature K (which would mark the proportional limit) until a proportional-limit fiber stress as calculated by the formula

$$f_p = \frac{M_y c}{I} \qquad (2)$$

well above that in direct compression is reached. The theory breaks down when it comes to explaining the different moduli of rupture obtained in deep and shallow beams and in beams of various shapes. According to this theory, for rectangular beams or other beams symmetrical about their centers, no matter what the depth, the moduli of rupture should be the same.

Newlin-Trayer Theory:

Newlin and Trayer (4) advanced the theory that only by some supporting action among fibers could the variations in modulus of rupture and proportional limit with changes in depth and cross-section be explained.

Briefly, the theory argues that the slender, hollow, tapering cells comprising the great mass of woody tissue act in compression somewhat like small Euler columns, restrained against buckling as a whole and partially restrained against buckling of the cell walls by their neighbors by means of the lignin encrustation which serves to bind the individual cells together.

In a block subjected to axial compression all cells are equally stressed, tend to buckle equally, and cannot give one another much support. In a bent beam, however, the compressive stress falls off from a maximum at the fiber most distant from the neutral axis to zero at that axis and then changes to tension. The fibers less stressed in compression are able to give their more highly stressed fellows a considerable measure of support against buckling. Two tendencies are, consequently, present. The fibers nearest those most highly stressed are able to make their support most effective but are themselves quite highly stressed, and can, therefore, yield only little actual support. The fibers nearer the neutral axis are inherently able to give more support because they are less stressed, but are more distant from the most highly stressed fibers so that their aid cannot be as effectively extended. Somewhere between the outer edge and the neutral axis the optimum support is found.

The theory fits the observed phenomena very well. In shallow beams the compressive fiber stresses fall off rapidly, hence the relatively little-stressed cells are quite close to their highly stressed fellows and can render effective aid. In deep beams the fiber stresses fall off slowly, and the less stressed cells, being farther distant, cannot offer as much help as in shallow beams. Consequently, both proportional limit and modulus of rupture are lower in deep beams than in shallow beams.

Although the theory explains the observed phenomena, certain points are left in doubt.

1. Do sections of timber beams, plane before bending, remain plane after bending? If the supporting fiber theory is correct, is it not necessary that a redistribution of strains take place as the more highly strained cells lean upon their neighbors for support, thereby causing the strain distribution to change from a straight line to a curve? If the strain distribution tends toward a curve, is it a curve at stresses below as well as above the proportional limit?

2. Is it true that, below the proportional limit, the neutral axis is found at the center of depth, rather than shifted toward the tension side?

3. Does the stress-strain relationship for the outermost fibers remain a straight line up to a higher stress intensity than is true of the fibers in a block subjected to axial compression, and is this the explanation for the higher proportional limit observed in beams?

In this paper are presented the results of flexural tests correlated with direct tension and direct compression tests, to determine the actual behavior of wood under these loading conditions, and to check the validity of the theories proposed.

Materials

Rectangular beams 5 in. deep and $1\frac{1}{4}$ in. wide were chosen. This depth was great enough to make possible a satisfactory study of strain distribution across the depth of the beam and still not so large as to obliterate the supporting action of less-strained fibers as postulated by the Newlin-Trayer hypothesis. Consequently, the ordinary beam assumptions, the Bach-Baumann theory, and the supporting-fiber theory could all be studied.

Five beams were tested, three at low moisture content and two near the fiber saturation point.

Test pieces were cut from three pieces of edge-grained Douglas fir carefully selected for straight grain, uniform rate of growth, and even texture. Each timber was split down the center. One half was conditioned to a final

moisture content of 24 per cent, the other half to 9 per cent.

Beams, $1^1/_4$ in. wide, 5 in. deep, and 60 in. long, were cut from this stock. After completion of the flexure test, direct tension and compression specimens were cut from the least stressed portions of the beams, so that the best possible matching material for all the tests was obtained.

Inasmuch as tensile properties of wood have been little studied, several different types of tension test specimens were tried. The best was a piece $^1/_2$ in. thick, 2 in. wide, and 28 in. long tapered at the center to $^1/_4$ in. thick and 1 in. wide for a length of 6 in. This was fairly easy to make and gave satisfactory results. Compression specimens were 1 in. square and 6 in. long.

Test Methods

Strain-Measuring Apparatus:

The conditions of the problem required:

(*a*) Sensitivity over a large range of strains, running from a few hundred thousandths in the region of the neutral axis in the beams to over 1 per cent in the tension test specimens.

(*b*) Absence of mechanical errors and local disturbances such as may be introduced by gages depending upon sharpened members inserted into gage points.

(*c*) The greater precision to be obtained by measuring along the arc of the elastic curve of a member instead of measuring the chord distance between two points on the curve.

(*d*) Ability to make many readings on a large number of gages.

(*e*) The necessity of keeping gage lengths relatively short, particularly in the tension and compression pieces.

To meet these conditions, cemented wire gages of the type developed by Ruge and de Forest at Massachusetts Institute of Technology were employed. These measure strains by measuring the changes in resistance of fine wires cemented to the surface of the body being strained. Compression causes resistance to drop, tension causes it to rise. Work by Meyer (*5*), Anderson (*6*), and the author showed that the change of resistance of the types of wires employed (Elinvar and Constantan) is a linear function of the strain up to strains of 2 or 3 per cent. Inasmuch as maximum strains approximating 1 per cent were encountered in this investigation, the linearity of the strain to change of resistance function simplified the calculations considerably.

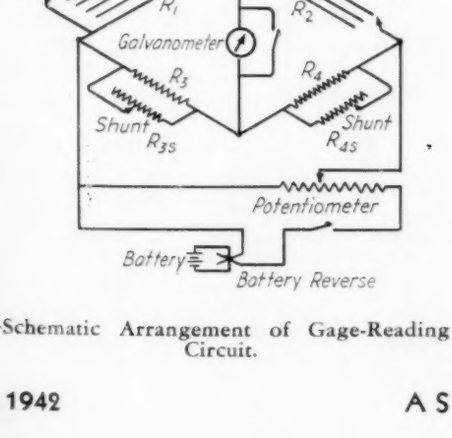


Fig. 3.—Schematic Arrangement of Gage-Reading Bridge Circuit.

Measuring Circuit.—Changes in resistance were measured by a modified bridge circuit.

The usual balanced Wheatstone bridge relationship is

$$\frac{R_1}{R_2} = \frac{R_3}{R_4} \qquad (3)$$

A change of resistance, ΔR_1 in the arm R_1, is countered by a proportionate change in another arm for balance. If R_1 is the gage, then R_2, the balancing arm, is best made of another gage (dummy) which is not stressed. Changes in R_1 are consequently balanced by altering R_3 or R_4. Greater sensitivity is obtained if, instead of reading R_3 or R_4 directly, fairly high resistance shunts R_{3s} and R_{4s} are placed across these arms and the box is balanced by altering the shunts (Fig. 3). The equation becomes

$$\frac{R_1}{R_2} = \frac{\dfrac{R_3 R_{3s}}{R_3 + R_{3s}}}{\dfrac{R_4 R_{4s}}{R_4 + R_{4s}}} \qquad (4)$$

The original (unstrained) length of each gage is read in ohms by balancing the circuit for each gage. R_{4s} is set at a fixed value for the unstrained condition and a corresponding value of R_{3s} for each gage is found. When a gage R_1 is strained to R'_1, if R_{3s} is set at the unstrained reading, a new reading R'_{4s} results when the circuit is balanced. The equation for strain becomes

$$ke = \frac{\Delta R_1}{R_1} = \frac{R_4}{R_4 + R_{4s}} \cdot \frac{\Delta R_{4s}}{R'_{4s}} \qquad (5)$$

which simplifies to

$$e = C \frac{\Delta R_{4s}}{R'_{4s}} \qquad (6)$$

where e = strain in inches per inch, and
k = a constant to convert ohms per ohm to inches per inch.

Since R_{4s} is the same for every gage, the first two terms of the final equation become a single constant C.

With a $1^1/_2$-v. battery across the circuit and a zero-strain shunt reading of 3000 ohms, readings of one part in one hundred thousand were read with an error of approximately 5 per cent.

Arrangement of Gages:

On direct tension and compression specimens, wires were cemented in series pairs to opposite sides of the piece at the center of length. Generally, the wires were straight but in some instances their length (4.25 in.) was too great and they were bent into the form of a hairpin to decrease their length in inches while the ohmic length remained the same. On the beams, gages were cemented at the center of length in series pairs at intervals down the sides of the beams, from top to bottom, parallel to the edges of beams. Gages were bunched at the edges and at the center of depth, from 15 to 21 pairs being used on each beam, at distances apart varying from 0.15 in. to 1.05 in. (Fig. 4). By using pairs, one gage of each pair on each side of the specimen, any slight eccentricities in loading were averaged out.

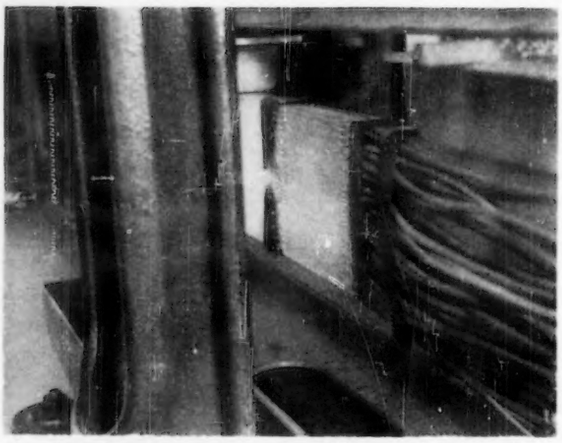


Fig. 4.—Arrangement of Gages on Edges and Sides of Beams. Series—pair connections at left, individual leads at right.

Testing Procedure:

Beams were loaded at the third-points on a 60-in. span. Loads were applied through hard maple pillow blocks, 2 by 2 by 8 in., slightly rounded at the bottom to prevent localized crushing of the wood fibers.

Two loading procedures were employed. In the first test runs the load was run up from zero through the several intervals to the highest load for that run and down again for each gage. In the subsequent runs, the load was run up to the desired value, allowed to come to equilibrium, all gages were read, and then the process was repeated for the next increment. In either instance, once the reading of the gages had begun, the head of the machine was not moved; consequently these tests were made at constant deflection. To see whether the time elapsed between reading the first and last gage had any effect upon the shape of the strain curve, gages were read in some instances from top to bottom and in others from bottom to top. No appreciable difference was observed.

Compression and tension specimens were subjected to loading and unloading cycles corresponding to the beam cycles so that the stress-strain curves obtained under direct stress might be correlated with the corresponding beam curves.

Compression specimens were loaded through two smooth half-spherical steel blocks resting in smooth steel sockets. Loads were run to the desired point and the strains read. Tension specimens were tested by carefully centering in jaws and pulling along the axis of the piece.

In all cases the loading rate for direct stress was correlated as closely as possible with the rate at which the beams were loaded.

Test Data

Figure 5 summarizes the results obtained from all direct tension and direct compression tests after making adjustments necessitated by small differences in density among the matched samples.

In Fig. 6 are plotted the strains observed on one dry beam, typical of all, through two loading cycles. The compression edge is at the top, tension at the bottom; compressive strains are plotted to the left, tensile to the right. The corresponding loads are indicated at the tops of the sheets, as are the values of fiber stress as calculated by the ordinary beam formula.

In Fig. 7 the strains recorded for the individual gages are replotted as complete curves for each gage for each cycle. Distance left to right represents the full depth of the beam. Compressive strains are plotted to the left of the perpendicular for each gage, tensile strains to the right. Strains are plotted against the values of extreme fiber stresses calculated by the ordinary beam formula.

In Table I the essential data are tabulated for comparison with the curves in Figs. 5 to 7, inclusive.

Discussion of Data

Direct Tension and Direct Compression:

Examination of the curves and table reveals the following:

1. In direct compression Douglas fir proves to be elastic to between 60 and 70 per cent of the ultimate strength. That is, upon release of load, no hysteresis is observed. At 60 to 70 per cent the proportional limit is reached, and hysteresis becomes rapidly more marked as the load approaches the ultimate. Upon reloading, in spite of previous loading beyond the proportional limit, the stress-strain curve remains straight to essentially the same proportional limit as before although the slope is slightly lowered.

2. In direct tension a peculiar stress-strain relationship appears. In dry material, upon loading, the curve remains essentially straight to high loads, but upon unloading, noticeable hysteresis is observed even at relatively low loads. In many

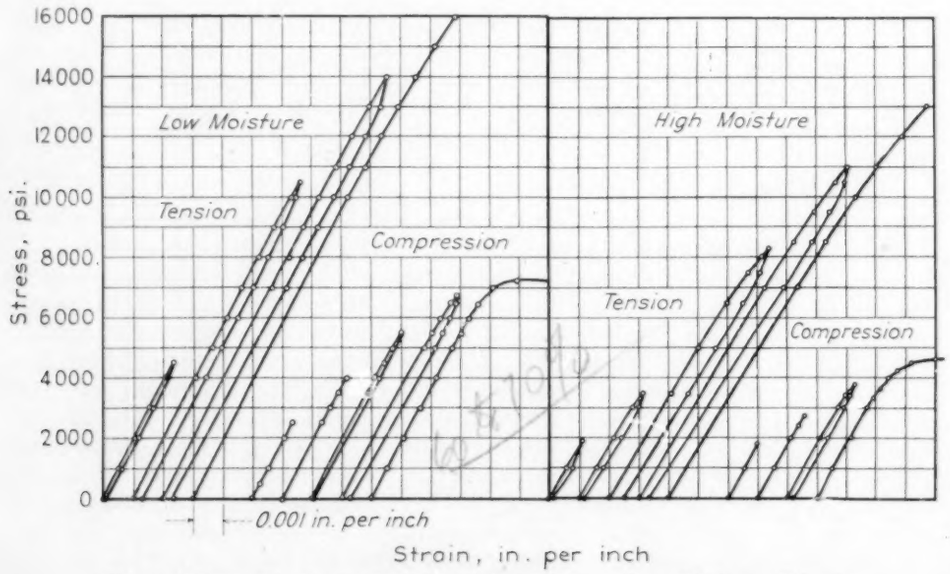


Fig. 5.—Direct Tension and Compression, High and Low Moisture Content.

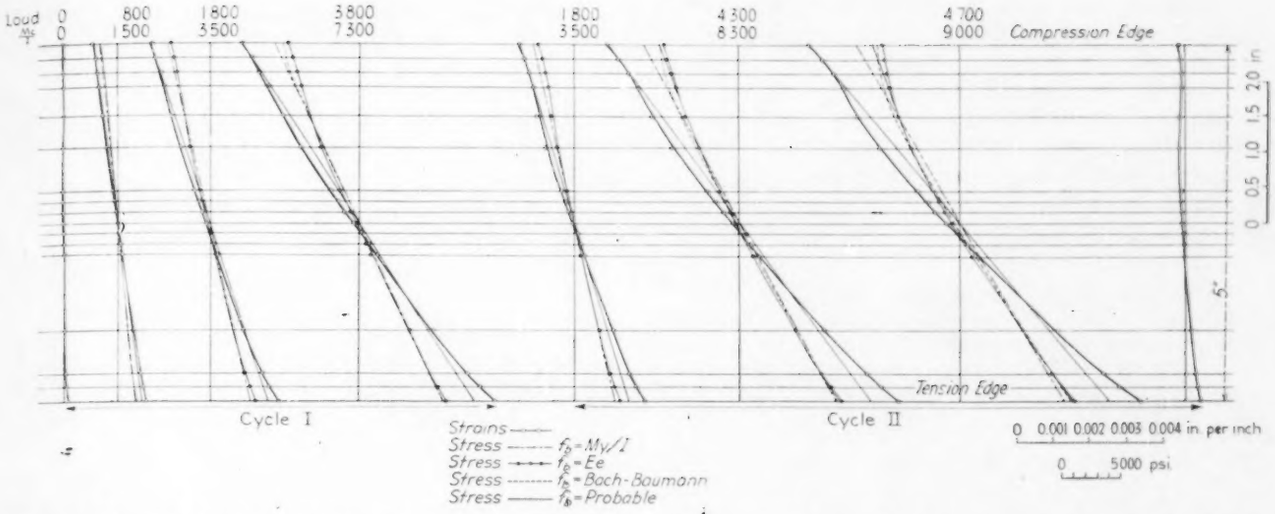


Fig. 6.—Observed Strains, with Stresses Computed According to Various Theories. Dry beam, loaded through two cycles.

cases the loading curve for dry material is straight to the breaking point, although in others a slight curvature becomes apparent at 75 to 80 per cent of the ultimate strength. In material at high moisture content, the stress-strain curve shows marked hysteresis almost from the very start and the loading curve begins to deviate from a straight line at much lower stresses than in dry material, deviation becoming apparent at 50 per cent or less of the ultimate strength.

As a consequence of this effect, it seems hardly correct to speak of a true proportional limit in tension in the sense that the term is used in compression where it is practically synonymous with elastic limit.

Part of the deviation from a straight line at high tensile stresses, particularly in dry material, seems to be caused primarily by successive failure of springwood fibers rather than by any increase in the rate of elongation of the fibers. This was strikingly indicated during testing by the appearance of fine cracks, accompanied by faint snaps, in the springwood portion of many test pieces, after which the stress-strain curve showed an abrupt change in direction but remained straight until further springwood cracks occurred. Evidently, the effective area was reduced, resulting in an apparent rather than real inclination of the stress-strain curve.

3. Ultimate strength in tension appears to be much more variable than in compression because tensile strength

TABLE I.

Direct Stress	Modulus of Elasticity, 10^6 psi. E_c	Modulus of Elasticity, 10^6 psi. E_t	Proportional Limit Stress, psi.	Percentage of Ultimate Strength	Ultimate Strength, psi.
Compression:					
Dry	1.98	....	4950	70	7 150
Moist	1.78	....	3050	69	4 500
Tension:					
Dry	....	2.05	....	..	15 000
Moist	....	1.83	....	..	12 750

	Load, lb.	$\frac{Mc}{I}$, psi.	Neutral Axis, Percentage of Depth	Strain in Extreme Fiber, 10^{-3} in. per Inch e_c	e_t
Bending:					
	0	....	....	....	....
	800	1500	51.5	0.70	0.78
	1800	3500	52.5	1.53	1.88
Cycle I	3800	7300	52.5	3.18	3.71
	1800	3500	53.0	1.53	1.88
	800	1500	52.5	0.70	0.78
	0	....	....	....	....
	0	....	....	....	....
	1800	3500	51.5	1.49	1.93
	4300	8300	52.0	3.61	4.37
Cycle II	4700	9000	53.5	4.13	4.93
	4300	8300	53.0	3.99	4.75
	1800	3500	53.0	1.87	2.35
	0	....	63.0	0.14	0.37
Ultimate	4800	9200	54.0	4.19	5.04
Proportional Limit	3850	7400	....	....	....

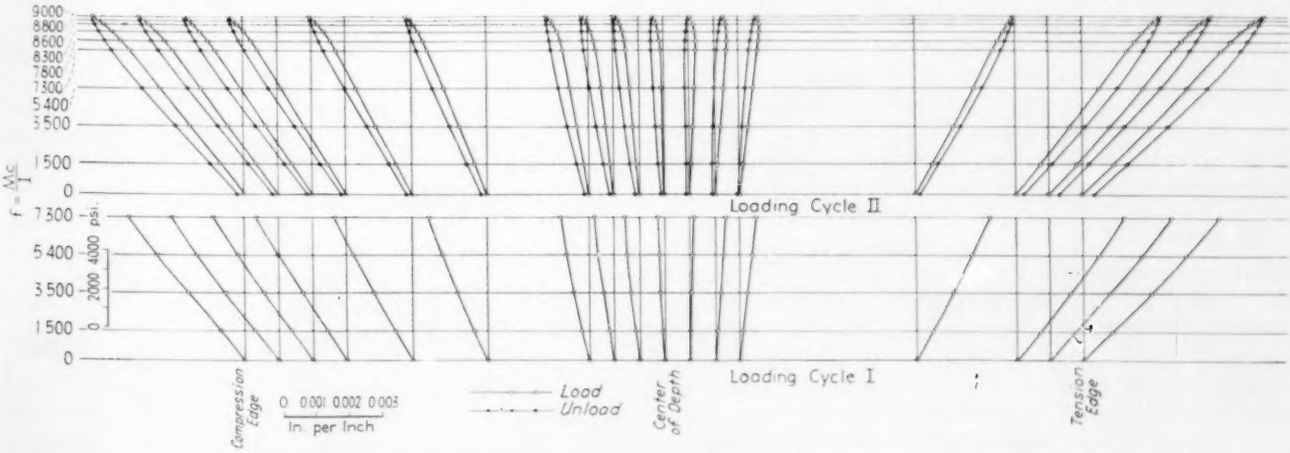


Fig. 7.—Loading and Unloading Stress-Strain Curves for Individual Fibers. Two loading cycles.

is quite sensitive to small deviations in the slope of the grain. However, the ultimate tensile strength is at least twice the ultimate compressive strength and averages approximately two and one half times as high.

Modulus of elasticity in tension averages 4 to 5 per cent higher than in compression.

4. Increased moisture content brings about the following average reductions:

Modulus of elasticity:	
E_t	12 per cent
E_c	11 per cent
Proportional limit, compression:	
Stress	39 per cent
Percentage of ultimate strength	2
Ultimate strength:	
Tension	15 per cent
Compression	37 per cent

Beams:

The arresting feature of all curves in Fig. 6 is their deviation from a straight line. Strains are not directly proportional to their distance from the neutral axis, and the neutral axis is depressed below the center of gravity. On the compression side, the strain curve is convex outward at approximately one third the depth, but tends to reverse its curvature as the top of the beam is approached. On the tension side it is essentially straight until the bottom is approached, where it tends to become concave outward. The outermost compression fiber is less strained than is the outermost tension fiber.

The general features of the Newlin-Trayer hypothesis of supporting action for the outermost compression fibers by those nearer the neutral axis are, therefore, confirmed.

Three more striking features of wood's behavior in bending are revealed by Fig. 7.

(*a*) The proportional limit in bending, as indicated by the beginning of deviation from a straight line stress-strain curve and the development of a hysteresis loop, is higher in bending than in direct compression. Although fiber stresses, particularly on the compression side, are high in cycle I, there is no hysteresis effect.

(*b*) *When deviation from the straight-line stress-strain relationship occurs, it occurs in all fibers simultaneously, even in those near the neutral axis which are strained much less than the proportional limit under direct axial load.*

(*c*) When the proportional limit is reached, deviation in the direction of increased compressive strains occurs even below the neutral axis, where fibers are stressed in tension. This shift is marked enough to cause tension fibers near the neutral axis to change from tension to compression. Not until well toward the outer tension edge do the stress-strain curves begin to deviate toward increased tension. Beyond the proportional limit, hysteresis loops occur in all fibers except at the point of transition from compression to tension. Even those near the neutral axis, which are strained far below the proportional limit in direct stress, show large hysteresis effects.

Until the proportional limit in bending is reached, residual strains at all points in the beam are practically negligible although the outermost fibers have been strained well beyond the point corresponding to proportional limit under direct compressive load. After the proportional limit in bending is passed, residual strains (permanent set) appear, with a larger residual strain area in compression than in tension and the "residual neutral axis" depressed well toward the tension side.

As shown in Table I, the proportional limit, as usually calculated, is 7400 psi. or 149 per cent of that in direct compression and the modulus of rupture is 9200 psi. or 129 per cent of the ultimate direct compressive strength. The proportional limit in bending is 80 per cent of the modulus of rupture. In this respect this particular beam runs higher than the average.

In Fig. 6 four stress curves are drawn for each load. The first is the usual one calculated by the formula

$$f = \frac{My}{I} \qquad (7)$$

The second curve is obtained by selecting from the curves in Fig. 5 (direct stress curves) the stress corresponding to each strain plotted in Fig. 6. This, in effect, is tantamount to multiplying each value of e by the value of E_c or E_t corresponding to it.

The third curve is that obtained by applying the Bach-Baumann theory. In Fig. 8 the direct tension and compression curves of Fig. 5 are replotted in accordance with this theory. For a given applied load there is an internal resisting moment with resultant tension and compression forces represented by portions of the areas under these curves. These are replotted on Fig. 6 as stress curves. They very nearly coincide with the Mc/I curves until the proportional limit in direct compression is reached, when they begin to deviate toward the eE curves.

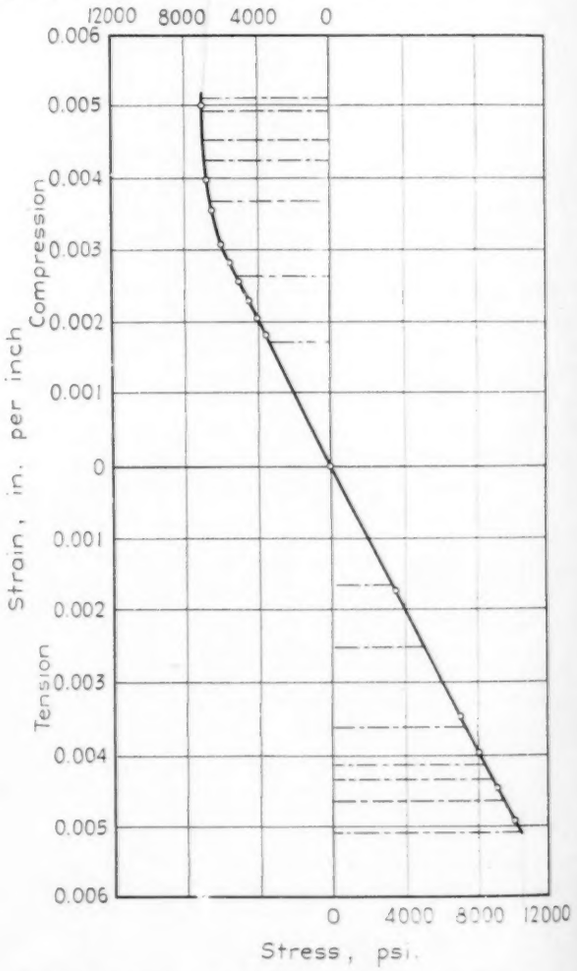


Fig. 8.—Direct Tension and Compression Curves Re-plotted in Accordance with Bach-Baumann Theory.

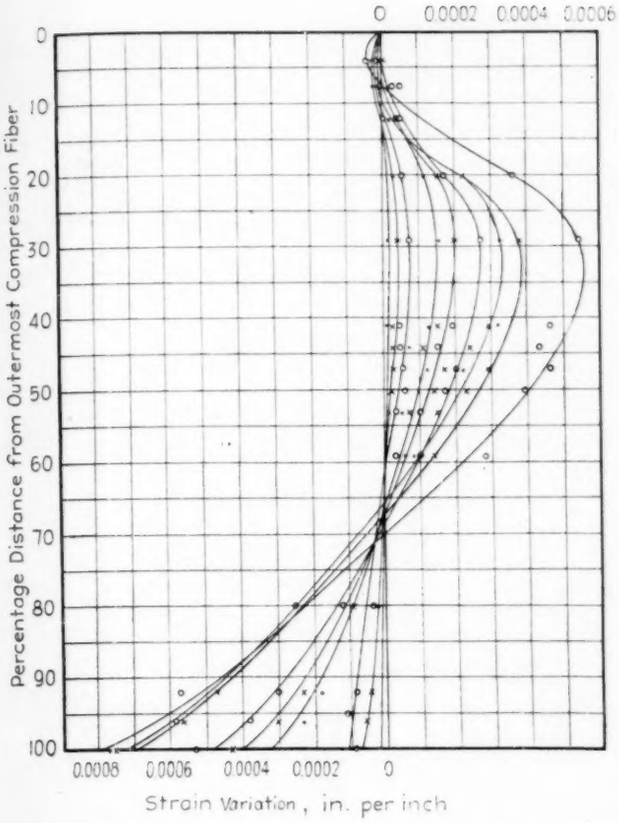


Fig. 9.—Strain-Variation Curves. Beam at low moisture content.

The Bach-Baumann curves predict failure at an Mc/I value corresponding to 9000 psi. which is only 2 per cent lower than the actual value obtained at rupture. To this extent the theory fits the facts very closely.

Neither the second curve nor the third curve is quite correct because the second curve assumes plane sections remaining plane and the third curve assumes that the strain at any point can be converted to stress by reference to the stress-strain curves under direct load. Under direct stress, however, all fibers are equally loaded and can give each other no support. In a beam, on the other hand, because of the support received from the inner fibers, the outer fibers are undoubtedly stiffened and can carry greater stress than can unsupported fibers in a short block. Consequently, the true stress curve is probably intermediate between the second and third curves and is as is represented by the fourth curve. At low stresses, the second and fourth curves coincide; at high stresses the fourth curve deviates so as to assume a shape more nearly proportional to the strain curve, and to approach more nearly a straight line than does the second curve.

Results for beams at high moisture were essentially the same as for dry beams, except that both proportional limit and modulus of rupture were lowered by very nearly the same percentage as in direct compression. The proportional limit was not so clearly defined as in dry beams.

Strain Variation:

Strain Difference Curves.—The strain curves of Fig. 6 all possess the same general shape and differ only in degree from low to high stresses. They all indicate that strain release takes place in the outer compression fibers with corresponding compressive strain increases in fibers nearer the neutral axis, and that the supporting-fiber theory, consequently, is correct.

These curves, considered still further, show the extent to which fibers lower in the beam offer the outer compression fibers some support by taking up the strains relinquished by the latter. The outer fiber obviously cannot give itself any outside support. Furthermore, if there were no strain transfer, sections plane before bending would remain plane after bending, and the strain curve would be a straight line passing through the center of depth. Consequently, the difference between the observed strain curve and a straight line drawn from the outermost compressive strain point through the center of gravity to the opposite edge may be taken as a measure of the net strain redistribution. When such lines are drawn in Fig. 6, several characteristics appear:

(*a*) Excess compressive strains exist to a point well below the neutral axis, showing that fibers stressed in tension are called upon to assist the compressive fibers.

(*b*) Excess tensile strains are found in the lower portions of the beams and reach a maximum at the outermost tensile fibers. It appears, consequently, that the compressive redistribution tendency is overcome by a counteracting tensile excess.

Strain Variations.—If the strain variations are plotted to a larger scale about a common vertical axis as in Fig. 9, the foregoing effects are brought out more clearly.

(*a*) The maximum compression variation occurs at approximately 35 per cent of the depth of the beam, depending upon the load, and occurs at successively lower points as the load is increased.

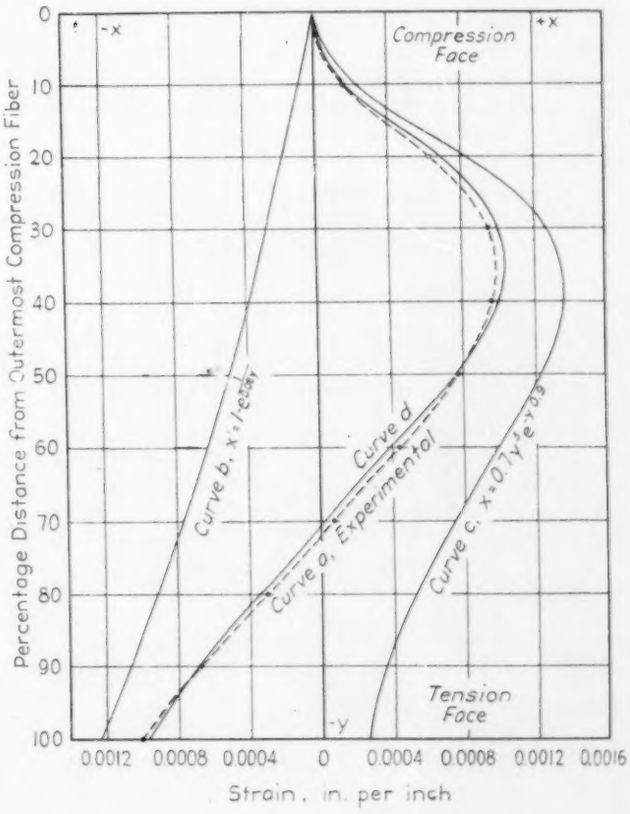


Fig. 10.—Experimental and Theoretical Strain-Variation Curves.

(*b*) The variation curves change from compression to tension at 60 to 75 per cent of depth of beam. The change occurs at successively lower points as the load is increased.

(*c*) As a consequence of the two foregoing observations, it would appear that the outermost compression fibers receive maximum assistance from the fibers approximately one third the depth of the beam from that edge and that more and more fibers deeper in the beam are called upon for assistance as the load is increased.

(*d*) Certain of the curves seem to indicate a negative compressive variation near the outermost compression fiber. This is probably more apparent than real since the average for all the beams tested approaches tangency with the vertical line at that point.

Characteristic Strain-Variation Curve.—If the ultimate curves of all beams are averaged, a composite or characteristic strain-variation curve is obtained, as plotted in Fig. 10.

The experimental shape of the curve is an approximation, but an approach to its probable shape may be made by considering the influences of compression and tension in the beam. Because of their slender, hollow shape, wood fibers in compression soon tend to buckle and consequently throw part of their strain on their less strained neighbors. This redistribution takes place successively and has a cumulative effect as it progresses downward in the beam. An inverse effect due to distance takes place, however, so that an optimum point must be reached beyond which aid diminishes and may be expected practically to disappear at the bottom. This kind of effect may well be represented by a distribution curve of the Pearson (*7*, *8*) type, class III,

$$P = k(x-a)^m e^{-nx} \quad \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

If the usual X and Y axes are adopted, letting $X-X$ represent the outer compression face, and taking the origin at the top so that a vanishes, this equation may be written

$$x = -ky^m e^{-ny} \quad \ldots\ldots\ldots\ldots\ldots\ldots (9)$$

but m must be greater than unity and n greater than zero.

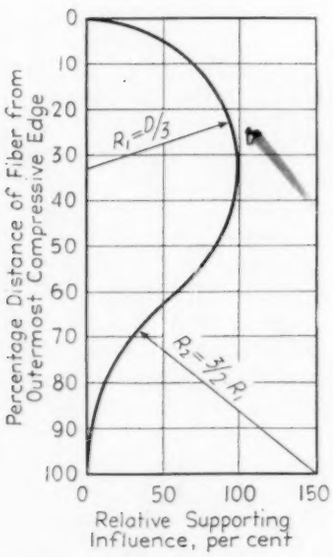


Fig. 11.—Newlin-Trayer Hypothetical Supporting-Action Curve.

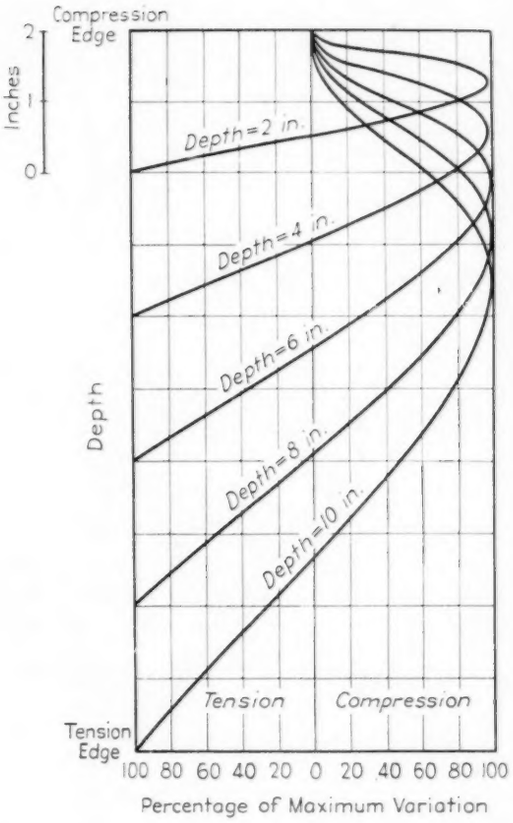


Fig. 12.—Strain-Variation Curves for Beams of Various Depths.

In tension, the wood fibers have no tendency to buckle. Consequently their effect upon the strain-variation curve should diminish from a maximum at the outer tensile face to zero at the compression face. A decay curve of the type

$$f(x) = e^{-x} \quad \ldots\ldots\ldots\ldots\ldots\ldots (10)$$

fulfills this condition and may be rewritten

$$x' = 1 - \frac{1}{e^{ay}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (11)$$

to fit this particular case.

Solving, it is found that if Eq. (9) is written

$$x = 0.7y^3 e^{y0.9} \quad \ldots\ldots\ldots\ldots\ldots\ldots (12)$$

and Eq. 11 is written

$$x' = 1 - \frac{1}{0.08y} \quad \ldots\ldots\ldots\ldots\ldots\ldots (13)$$

their algebraic sum yields curve (*d*) in Fig. 10, which closely approximates the experimental curve. It is interesting to compare this with the supporting-action curve postulated by Newlin and Trayer (*4*) and shown in Fig. 11. The similarity is marked.

Effect of Depth.—It has been pointed out that modulus of rupture decreases with increasing depth. If it is assumed that the general shape of the strain-variation curve is the same for beams of all depths, the reason for reduced modulus becomes clear. In Fig. 12, for instance, are plotted strain-variation curves for five different depths. If the upper curve represents the condition in the usual

standard 2-in. beam, then the others are 4, 6, 8, and 10 in. deep, respectively.

The slope of the upper portion of the curve for 2-in. depth is quite flat and the maximum compressive variation occurs a short distance from the outermost compressive fiber, indicating that assistance is rapidly and effectively being given the outer fibers. In the 10-in. beam the slope is five times as steep and the maximum compressive variation is five times as far from the outer fibers; consequently, aid is rendered much less effectively and the outer fibers fail at lower stresses, that is, at lower values of the modulus of rupture as ordinarily calculated. Seemingly, as the depth increases, a condition approaching zero stress-release is reached and the modulus of rupture becomes practically as low as the ultimate direct compressive strength. That this is true is borne out by experiment on timbers of various depths.

Summary and Conclusions

Direct Stress:

1. Douglas fir is elastic in compression to between 65 and 70 per cent of the ultimate strength. Beyond that point hysteresis appears and rapidly increases as the ultimate strength is approached. Increased moisture decreases proportional limit and ultimate strength approximately 40 per cent.

2. The tensile stress-strain curve is a straight line almost to the ultimate in dry Douglas fir, but deviates from linearity at 40 to 50 per cent of ultimate in Douglas fir at high moisture content. Hysteresis appears at relatively low stresses at both high and low moisture content. Increased moisture decreases the ultimate strength approximately 12 per cent.

3. The tensile modulus of elasticity is 4 to 6 per cent higher than the compressive, and both are decreased 10 to 12 per cent by increase in moisture content from 9 per cent to 24 per cent.

Bending:

1. Sections plane before bending apparently do not remain plane after bending but show a relative decrease in strains near the outer compression edge, and increase as the neutral axis is approached and a small increase at the outer tensile edge. Deviation from the plane increases with increasing bending moment.

2. The neutral axis is shifted below the center of gravity 2 to 3 per cent of the depth and remains practically stationary until the proportional limit is reached, when it migrates toward the tension edge.

3. The bending proportional limit is 140 to 150 per cent of the direct compression proportional limit, and modulus of rupture is 120 to 130 per cent of the ultimate compressive strength.

4. The supporting-fiber theory is confirmed and extended, inasmuch as the outer fibers are not only supported but relinquish part of the strain to the less strained fibers nearer the neutral axis. Strain transfer extends well into the tension side, as is shown by the shift of the neutral axis in that direction.

5. Until the bending proportional limit is reached, all fibers—tension, compression, outermost, and innermost—exhibit linear stress-strain relations regardless of whether they have been stressed beyond the direct stress proportional limit or not and no hysteresis appears. When the bending proportional limit is passed, all fibers, whether at high or low stress, exhibit marked hysteresis. It would appear that the restraining action of one fiber against the other builds up a condition of equilibrium among the fibers throughout the depth of the beam, and that the balance is upset simultaneously at all points when buckling or twisting of the cell walls finally occurs. The material may be said consequently, to behave elastically throughout until all elastic capacity is utilized, when further stress causes all elements to pass the proportional limit at the same time. At failure, maximum compressive strains are higher, in spite of strain release and because of support from below, than maximum strains at failure in direct compression.

6. A strain-variation or supporting action curve may be obtained by taking the difference between the actual strain curve and a straight line drawn from the outermost compressive strain point through the center of depth to the opposite (tension) edge. The curve may be considered to be a composite of two effects: (1) supporting-fiber action extending throughout the depth of the beam, starting at zero at the top, reaching a maximum at 35 to 40 per cent of depth and dropping off to zero; and (2) an opposing tensile deviation starting from the maximum at the tension edge and dropping to zero at the compression edge. Net compression support starts at the top and extends to from 60 to 75 per cent of depth, reaching a maximum at 30 to 35 per cent of depth.

7. The strain-variation curve explains the reduction in modulus of rupture with increased depth by showing that the maximum supporting action occurs at greater absolute distances from the most-stressed compression fibers in deep beams, hence cannot be as effective, and permits failure at lower relative loads.

It must be borne in mind that the foregoing conclusions are strictly applicable only to the species and type of material tested, namely, edge-grain Douglas fir. It seems reasonable to suppose, however, that other structural softwood species possessing similar cellular structure should behave in much the same manner inasmuch as all exhibit the same general differences in direct compression and bending behavior, and all show decreasing moduli of rupture with increasing depth of beam.

References

(1) L. J. Markwardt and T. R. C. Wilson, "Strength and Related Properties of Woods Grown in the United States," *Technical Bulletin 479*, U. S. Department of Agriculture, Forest Products Laboratory, Government Printing Office, Washington, D. C. (1935).

(2) L. J. Markwardt, "Form Factors and Methods of Calculating the Strength of Wooden Beams," Conference on Timber and Concrete, *Mimeograph R1184*, Forest Products Laboratory, Madison, Wis. (1938).

(3) C. Bach and R. Baumann, "Elastizitat und Festigkeit," pp. 300-308, 9 Auflage, Julius Springer, Berlin (1924).

(4) J. A. Newlin and G. W. Trayer, "Form Factors of Beams Subjected to Transverse Loading Only," *Report, No. 181*, Nat. Advisory Committee for Aeronautics, Government Printing Office, Washington, D. C. (1924).

(5) Hans Meyer, "Development of an Electrical Strain Gage and Its Application to the Stress Problem in Elevated Water Tanks," Doctor's Thesis (1940).

(6) A. R. Anderson, Unpublished Researches, Massachusetts Institute of Technology.

(7) Pearson, "Mathematical Contributions to the Theory of Evolution," *Philosophical Transactions*, Vol. 186, pp. 197-216.

(8) T. C. Fry, "Probability and Its Engineering Uses," Second Printing, pp. 244-251, D. Van Nostrand Co., Inc., New York, N. Y. (1928).

Terminology Relative to Volume and Specific Gravity of Granular Materials for Concrete

Discussion of Paper by Lewis H. Tuthill[1]

Submitted by Glenn Murphy[2]*:*

As Mr. Tuthill[1] has ably indicated, there is a decided lack of uniformity in the concrete literature concerning the designations of volumes and specific gravity. The present confusion cannot be alleviated until a set of consistent definitions has been adopted by some authoritative group such as the A.S.T.M.

The first two columns of Mr. Tuthill's Table I present a set of definitions which are consistent and reasonably descriptive, and the author is to be commended for compiling them. However, the first two terms, *loose bulk* and *consolidated bulk*, are rather long for general usage and might be shortened to *loose* and *consolidated*, respectively, without sacrificing their significance. While there is much to be said in favor of the term *apparent* to designate the volume (or specific gravity) excluding voids among particles and including voids within particles, it has the disadvantage of having been used in at least three other senses, as indicated in Table I. To designate this volume the writer suggests for consideration the term *effective*. Thus, the *effective volume* of the aggregate would indicate the volume effective in displacing a fluid such as, for example, the mortar in a concrete mixture, and the corresponding specific gravities would be the *effective specific gravities*. The term *effective* has the advantage of being reasonably descriptive and is new, thus eliminating any possible confusion in its use, if adopted.

For the sake of completeness, if for no other reason, the volume excluding permeable voids and including impermeable voids should be designated. The term *solid* might well be used for this purpose, with *absolute* reserved, as indicated, for the volume excluding all voids except intracrystalline voids.

The volumes as defined are indicated in the accompanying Fig. 1 with reference to voids. The solid lines represent the boundaries of the particles and the dotted lines indicate the boundaries of the volumes designated in the definitions. The voids, which consist of both permeable and impermeable spaces, are exaggerated for emphasis.

Figure 1 (*a*) represents the loose volume condition in which the distances between particles are appreciable in comparison with the sizes of the particles. The loose volume of a mass of particles may be obtained from the over-all dimensions of the mass as heaped or as placed in a container. The loose volume which a given mass occupies depends upon the method of placement and the moisture content of the mass.

Figure 1 (*b*) indicates the consolidated volume of the same group of particles as are shown loose in Fig. 1 (*a*). The consolidated volume may be measured by placing the particles in a container following a standardized procedure, such as that outlined in the A.S.T.M. Standard Method of Test for Unit Weight of Aggregate (C 29 – 39).[3] The volume of a mass of fine aggregate deposited under water in a container (inundated) usually approximates the consolidated volume obtained by dry-rodding or jigging.

The dotted lines in Figs. 1 (*c*) and 1 (*d*) outline the effective volume of an individual particle. Permeable voids are indicated as having capillary openings to the outside surface and the impermeable voids are indicated as the spaces not connecting with the outside surface. In the saturated surface-dry condition the permeable voids are assumed to be filled with water. For the oven-dry condition the capillary spaces are shown devoid of water; however, they will generally contain some moisture—the equilibrium content for the surrounding atmospheric conditions. The effective volume of a given mass (in cubic centimeters) may be evaluated as the weight (in grams) of the mass in air in the saturated surface-dry condition minus the weight (in grams) of the mass immersed in water.[4]

The solid volume of a particle, as indicated by the dotted lines in Fig. 1 (*e*), includes the impermeable voids, but excludes the permeable voids. It may be evaluated (in cubic centimeters) as the weight (in grams) of the oven-dry sample in air minus the weight (in grams) of the saturated sample in water.[5]

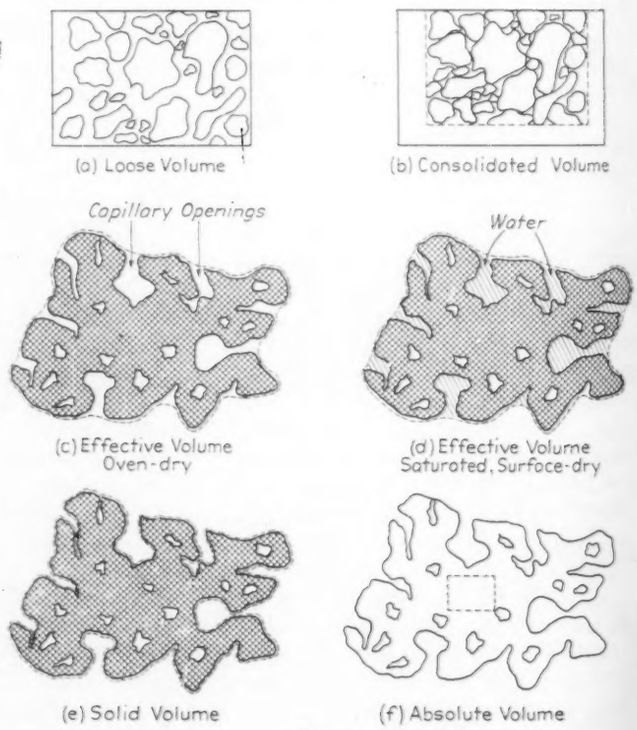


Fig. 1.

[1] Lewis H. Tuthill, "Terminology Relative to Volume and Specific Gravity of Granular Materials for Concrete," ASTM BULLETIN, No. 115, March, 1942, p. 17.

[2] Professor of Theoretical and Applied Mechanics, Iowa State College, Ames, Iowa.

[3] 1939 Book of A.S.T.M. Standards, Part II, p. 308.

[4] This corresponds to the term *B-C* in A.S.T.M. Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate (C 127 – 39), 1939 Book of A.S.T.M. Standards, Part II, p. 300.

[5] This corresponds to the term *A-C* in Method C 127 – 39, *loc. cit.*

The absolute volume of a portion of a single particle is indicated in Fig. 1 (*f*) as the volume within the dotted lines. The volume contains no voids except those which exist within the boundaries of the individual crystals. The absolute volume of a given stone, for example, may be determined by grinding the stone into particles sufficiently small to eliminate all voids between crystals and evaluating the total solid volume of the particles by the Le Chatelier flask or other appropriate means.

The writer agrees with Mr. Tuthill that the term *density* should not appear in the definitions. The scientific definition of density, as adopted in physics, chemistry, and mechanics, is *mass* per unit volume,[6] as distinguished from specific weight, or unit weight, which is *weight* per unit volume, and from specific gravity which is the ratio of the weight of a unit volume of the material to the weight of an equal volume of water under prescribed conditions. The terms *density* and *specific gravity* have been confused by some engineers (and others) because they have the same numerical value in the absolute metric system.

As the author has mentioned, the term *solidity ratio* has been suggested to avoid the misuse of density to designate the percentage of solid material in a given volume.

Submitted by W. H. Price[7]*:*

In addition to the confusion existing in the terminology applied to volume and specific gravity of granular materials for concrete, as discussed by Mr. L. H. Tuthill, there also is a lack of consistency in the application of specific gravity, absorption, or surface moisture of aggregates in calculations in connection with portland-cement concrete. This confusion and these inconsistencies could be eliminated through the application of the procedure proposed by Mr. Tuthill, and it is recommended that immediate steps be taken toward that end to prevent further growth of this jumble.

Although specific gravity, absorption, and surface moisture of concrete aggregates are related terms, they usually are not referred to a common base as may be seen from the following discussion.

The bulk specific gravity for calculations in connection with portland-cement concrete may be determined on an oven-dry or saturated surface-dry basis (A.S.T.M. Methods C 127 – 39[8] and C 128 – 39[9]). The absorption is expressed as a percentage of the oven-dry sample (A.S.T.M. Methods C 127 – 39 and C 128 – 39). Surface moisture in fine aggregates is expressed as a percentage of the air-dry sample (A.S.T.M. Method C 70 – 30[10]). Bulk specific gravity on an oven-dry basis is evidently intended for use in the computations of voids in aggregate for concrete (A.S.T.M. Method C 30 – 37[11]), whereas bulk specific gravity on a saturated surface-dry basis is specified for computations of voids in fine aggregate (A.S.T.M. Method C 39 – 39[12]). Bulk specific gravity on a saturated surface-dry basis is specified for computations of moisture in fine aggregate (A.S.T.M. Method C 70 – 30). Actually *M*, the percentage of surface moisture in the fine aggregate as determined under A.S.T.M. Method C 70 – 30, is a percentage of the surface-dry saturated aggregate and not the air-dry aggregate as stated in the method, as may be seen from the following computations:

Let X = grams of free water in 500 g. of saturated wet sand,
s = specific gravity of sand (saturated surface-dry basis as in Method C 70), and
V = combined volume in millimeters of the water and fine aggregate in flask.

$$\text{Then } V = 200+\left(\frac{500-X}{s}\right)+X$$

$$Vs = 200s+500-X+sX$$

$$Vs = 200s+500+X(s-1)$$

$$X(s-1) = Vs-200s-500$$

$$X = \frac{Vs-200s-500}{s-1}$$

$$\text{and } 500-X = 500-\left(\frac{Vs-200s-500}{s-1}\right) = \text{weight of saturated surface-dry sand in sample}$$

$$= \frac{500s-500-Vs+200s+500}{s-1}$$

$$= \frac{500s+200s-Vs}{s-1}$$

$$\therefore M = \frac{X\cdot 100}{500-X} =$$

$$\left(\frac{\frac{Vs-200s-500}{s-1}}{\frac{500s+200s-Vs}{s-1}}\right)100 = \frac{V-\frac{500}{s}-200}{200+500-V}\times 100$$

This is the formula given in Method C 70 – 30 and it is here clearly derived on the basis of saturated surface-dry material.

It is logical that batch weights of wet or damp aggregate be based on surface-dry saturated weights and it seems equally logical that this basis be maintained throughout for convenience and because even air-dry aggregate will approach saturation before the concrete is placed in the form. Any water absorbed from the concrete mix by the aggregate should be considered as part of the aggregate, as this absorbed water does not occupy space available for other ingredients and as such water does not add to the fluidity of the mix. If this is accepted the batch weights of the aggregate should be reduced to a saturated surface-dry basis by taking into account the surface moisture or absorption and the bulk[13] specific gravity of the saturated surface-dry aggregate used in every case to compute the absolute[13] volume occupied by the aggregate in the mix.

It would appear that the whole matter could be simpli-

[6] Expressed in slugs per cubic foot in the system of units commonly used in engineering in the United States. Density may be evaluated by dividing the specific weight in pounds per cubic foot, by the acceleration of gravity in feet per second squared. Thus, the density of water is $\frac{62.4}{32.2}$ = 1.94 slugs per cu. ft.

[7] Engineer, U. S. Bureau of Reclamation, Denver, Colo.

[8] Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate (C 127 - 39), 1939 Book of A.S.T.M. Standards, Part II, p. 300.

[9] Standard Method of Test for Specific Gravity and Absorption of Fine Aggregate (C 128 - 39), *Ibid.*, p. 302.

[10] Standard Method of Test for Surface Moisture in Fine Aggregate (C 70 – 30), *Ibid.*, p. 217.

[11] Standard Method of Test for Voids in Aggregate for Concrete (C 30 - 37), *Ibid.*, p. 310.

[12] Standard Method of Test for Compressive Strength of Concrete (C 39 – 39), *Ibid.*, p. 328.

[13] The use of "bulk" and "absolute" to describe related factors is in accordance with current terminology. (See Table I of Mr. Tuthill's paper for suggested descriptive terms.)

fied if specific gravity, absorption, and free moisture of concrete aggregate were all based on a saturated surface-dry basis. The voids in aggregate for concrete could be computed on a saturated surface-dry basis by adding to the air-dry weight the weight of the water necessary to bring the aggregate to the saturated surface-dry condition.

Submitted by Cloyd M. Chapman[14]:

Mr. Murphy's suggestion that the term "solid" might be used to designate a volume of granular material excluding permeable voids and including impermeable voids, leaving "absolute" to indicate volume excluding all voids except intracrystalline voids, seems to be bad. How is one to distinguish in practice between "impermeable" and "intracrystalline" voids?

Apparently Mr. Murphy does not intend to exclude merely all of the intercrystalline and to include all of the intracrystalline voids in the term "absolute" because he suggests a method of determining it which involves grinding the material so fine as to eliminate not only the voids between crystals but a large proportion, if not all, of the voids within the crystals.

I would prefer to use the term "absolute" to describe volume or specific gravity of material excluding all voids, both inter- and intracrystalline. Of course, such a volume could not be measured directly, except in the case of nonporous materials, but would have to be computed from other determinations.

As for the term "density," I doubt whether, out of the best one hundred concrete construction superintendents and foremen in the whole country, there are five who could define "density" correctly, and probably most of them would liken it to, rather than distinguish it from, specific gravity. The word is not needed in the construction industry's vocabulary of terms relating to volume and specific gravity of aggregates for concrete.

Mr. Price's argument for basing determinations of batch weights on saturated, surface-dry condition strikes a responsive chord in the present writer, who has held that opinion for many years. It seems not only the most logical basis but the one that can be easily determined with reasonable accuracy (with a little practice) using simple field apparatus and methods.

[14] Chairman of Subcommittee V, Editorial and Definitions, of Committee C-9 on Concrete and Concrete Aggregates; Consulting Engineer, Glen Cove, N. Y.

Comments by Lewis H. Tuthill[15]:

The discussions submitted by Glenn Murphy and W. H. Price are welcome and very worth-while additions to the general message in the original paper.

Mr. Murphy's Fig. 1 is a valuable visual aid to a clear conception of the several aspects of volume which must be recognized in connection with granular materials for concrete. This figure is particularly recommended as a complementary figure which clearly illustrates the distinctions in volume described in Table I in the paper. No objections are offered to his suggestions for the terminology; his word "effective" for the volume within the apparent surface of the particle is especially good. Lacking better suggestions, those charged with review and recommendation of terminology should give these terms consideration.

Mr. Price's plea for coordination of A.S.T.M. standard procedure is timely and appears amply justified from the inconsistent state of affairs he has described. His suggestion that all the pertinent standards be made consistent on the basis of saturated surface-dry "effective" volume is heartily endorsed.

It might be mentioned that from a number of sources there has been received word of approval of the general theme of the paper that consistent clarification of the subject is needed. No objections have been received since the paper was published. Thus it would seem there is a recognized need for action and it is hoped these suggestions may be the beginning of a fuller and official consideration which will ultimately clear up this matter to the satisfaction and relief of the great majority of all concerned.

[15] Concrete Engineer, U. S. Bureau of Reclamation, Denver, Colo.

Questionnaire—Tests on Die Castings

At the March, 1941, meeting it was suggested to Subcommittee IV on Physical Tests of Die Castings of the Society's Committee B-6 on Die-Cast Metals and Alloys that perhaps the use of die castings was restricted by lack of a test to determine the soundness and critical properties. As a result of the discussion which followed, a questionnaire was submitted to the approximately 75 members of Committee B-6. The questions with a brief summary of the 25 replies received follow:

1. *What tests—routine, proof, or service—do you conduct to determine soundness, strength, or general satisfaction of die castings? Please describe any special tests in detail.*

Nine used X-rays, six macroexamination, six special tests correlated to service requirements, five the tension test, and smaller numbers used any one other test.

2. *Do you use the "supersensitive density test?" If so, please report briefly the satisfaction of results obtained.*

No one used the supersensitive density test. Apparently very few understood it, a few thought is misleading, and a few more would like to have more information about it.

3. *In your opinion, is the use of die castings restricted by the lack of a method of test for any property or properties?*

Fourteen replied, yes; seven, no; and four, no answers.

In a detailed discussion of the returns from this questionnaire, the consensus was that failures and dissatisfaction in the use of die castings have been caused largely by:

1. Failure to design the casting properly.
2. Failure to enforce A.S.T.M. specifications.
3. The spreading of die casting jobs to incompetent die casting concerns, perhaps through the present system of competitive bidding.

The conclusion was that Subcommittee IV did not have any all-inclusive test to offer which would answer the problem of determining the general satisfaction of all die castings.

E. H. Kelton
Secretary, Subcommittee IV

Report on Air-Permeability Method for Determining Fineness of Cement

EDITOR'S NOTE.—This is a report of the Working Committee on Fineness of A.S.T.M. Committee C-1 on Cement. The report was prepared at the National Bureau of Standards under the direction of P. H. Bates, Chairman of the Working Committee.

IT HAS BEEN recognized that in the air-permeability method of determining fineness there are variations in specific surface value depending upon the porosity of the compacted bed of material and possibly the rate of air flow. It has also been recognized that some cements are more difficult to compact than others. It was, therefore, considered necessary that further information be obtained about the air-permeability method of determining fineness before a comprehensive specification could be drawn up for its use for portland cement and related material.

The purpose of the investigation was to determine:

1. The porosity to which the cements should be compacted;

2. The amount of variation of surface area values as obtained by different laboratories both when using a constant pressure across the apparatus and by using a constant rate of flow through the apparatus;

3. The "index of compaction"[1] as proposed by the Bureau of Reclamation; and

4. The variations obtained by different operators when using a constant weight to compress the samples of cement.

The air-permeability fineness tests on eight samples of cement were made in 20 laboratories each having its own permeability apparatus. A list of the cooperating laboratories together with the men representing these laboratories is as follows:

Aetna Portland Cement Co.	Paul Bischoff
Allentown Portland Cement Co.	M. D. Olver
Bessemer Limestone and Cement Co.	R. E. Roscoe
Bureau of Reclamation, Denver	R. F. Blanks
Dewey & Almy Chemical Co.	H. L. Kennedy
Glens Falls Portland Cement Co.	Chas. T. Raber
Green Bag Cement Co.	L. N. Bryant
Lawrence Portland Cement Co.	L. A. Eisenhard
Lehigh Portland Cement Co.	J. C. Pearson
National Bureau of Standards, Seattle	E. T. Carlson
National Bureau of Standards, Washington	R. L. Blaine
Marquette Cement Mfg. Co.	J. C. Witt
Missouri State Highway Dept.	F. V. Reagel
Missouri Portland Cement Co.	L. A. Wagner
Penna. Dixie Cement Corp.	L. C. Hawk
Peerless Cement Corp.	A. C. Eichenlaub
Portland Cement Association	H. F. Gonnerman
Southwestern Portland Cement Co.	S. L. Meyers
Universal Atlas Cement Co.	G. L. Lindsay
Whitehall Cement Mfg. Co.	M. H. Meighan

The order in which the results are tabulated is not the same as the listing of the cooperating laboratories.

The eight samples of cements were identified by number as follows:

No. 1, a portland cement.
No. 3, a moderate heat portland cement.
No. 4, a portland cement with Vinsol resin interground.
No. 5, a high-early-strength portland cement.
No. 6, a portland pozzuolana cement.
No. 7, a portland cement raw mix.
No. 8, a masonry cement.
No. 9, a masonry cement "waterproofed."

The following set of instructions were furnished to the cooperating laboratories:

The proposed tests are as follows:

(*A*) A study of the variations of specific surface values with porosity when using a constant pressure across the apparatus and the determination of the variations of results of different laboratories.

(*B*) A study of the degree of compaction.

(*C*) A study of variations of results of different laboratories when using the same rate of flow through the bed of powder.

(*D*) A study of the variations of specific surface values as obtained by different laboratories when using a constant weight to compress the samples of cement.

Before making any of the tests, make certain that the permeability apparatus is in good working order. It is especially important to check the rubber gasket of the permeability cell to make certain that it forms an airtight seal and also to check the entire apparatus for air leaks. Make certain, also, that the plunger is correctly adjusted to make the proper depth of bed.

In order that the conditions of test in different laboratories be as nearly alike as possible it is suggested that a 1-in. (2.54-cm.) diameter cell be used with a depth of bed of 1.85 cm. (total volume of bed 9.37 cu. cm.). The specific gravities of cements Nos. 1, 3, 4, and 5 are assumed to be 3.15. The specific gravities of cements Nos. 6, 7, 8, and 9 were determined in this laboratory with the following results:

Cement	Specific Gravity, g. per cu. cm.
No. 6	3.08
No. 7	2.73
No. 8	2.91
No. 9	2.87

It is suggested that these specific gravity values be used in the calculations of porosity and therefore also in the specific surface calculations.

The samples are to be tested as received without any drying or heat treatments.

The testing procedure is as follows:

1. Weigh out the required amount of cement to 0.01 g., and place in the permeability cell.
2. Tap the sides of the cell to consolidate and level the powder.
3. Insert plunger without turning and compress the cement slowly until the collar of the plunger is in contact with the top of the cell. (After this operation care must be taken not to jolt or jar the permeability cell.)
4. Turn the plunger one complete revolution, keeping the collar of the plunger in contact with the top of the cell.
5. Remove the plunger slowly and with a rotary motion.
6. Remove the cement from the sides of cell and plunger and from the vent hole in the plunger and return this cement to the permeability cell.
7. Repeat 3, 4, 5, and 6 above.
8. Connect the permeability cell to the apparatus and start the flow of air. (Care must be taken to insure a good seal between the cell and the apparatus.)
9. Record manometer readings when the levels of the liquids of manometers are in equilibrium—usually 3 to 5 min.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia, Pa.

[1] *Report No. Ce34*, U. S. Bureau of Reclamation, Denver Laboratory, December 8, 1941.

The formula as proposed by Lea and Nurse will be used for the calculations of specific surface values.

$$S_w = \frac{14}{P(1 - E)} \sqrt{\frac{E^3 A h_1}{C L h_2}}$$

where

S_w = specific surface in square centimeters per gram,
P = specific gravity of powder,
E = porosity,

$$= 1 - \left[\frac{\text{wt. of material in g. per density in g. per cu. cm.}}{\text{vol. of bed in cu. cm.}} \right],$$

A = area of bed in square centimeters,
L = depth of bed in centimeters,
h_1 = difference in level of liquid in manometer measuring pressure difference across the bed of material,
h_2 = difference in level of liquid in manometer measuring pressure difference across the capillary, and
C = constant for the capillary flowmeter.

$$C = nQ/h_2 P_4$$

where

Q = rate of flow in cubic centimeters per second,
n = viscosity of air in dynes per second, and
P_4 = density of liquid in manometer measuring pressure difference across the capillary.

Tests:

Make duplicate determinations of all tests.

(*A*) Make permeability tests with a constant pressure across the apparatus such that $h_1 + h_2 = 40 \pm 1$ cm. of kerosine.

Use the following weights of samples:

Cement	Weight of Samples, g.
Nos. 1, 3, 4	13, 14, 15, 16
Nos. 5, 6, 8	13, 14, 15
Nos. 7, 9	12, 13, 14

(*B*) Using the above prepared bed in each case determine the "index of compaction" after the permeability test has been made. A standard Vicat apparatus is used for this test and the method is that proposed in the Bureau of Reclamation (Denver) Laboratory Report No. Ce34, as follows: "The large end of the movable rod, 1 cm. in diameter, shall be allowed to drop through a distance of 2 cm., measured from the surface of the bed, onto the bed of material." The penetration of the plunger in millimeters shall be reported as the index of compaction, *Ic*.

(*C*) Make permeability tests of each of the cements using a constant rate of air flow of 0.14 ± 0.01 ml. per sec. (approximately 1/2 liter per hour). Use the following quantities of cement:

Cement	Weight of Sample, g.	Cement	Weight of Sample, g.
Nos. 1, 4, 6	15		
No. 3	16	No. 7	13
Nos. 5, 8	14	No. 9	12

In computing the h_2 corresponding to a flow of 0.14 ml. per sec. make use of the formula

$$C = nQ/h_2 P_4$$

and solving for h_2

$$h_2 = Qn/CP_4$$

you can assume a value of 0.8 for P_4 and a value of 181.0×10^{-6} for n. Use the C value furnished with your instrument.

In a sample calculation where $Q = 0.14$, $n = 181.0 \times 10^{-6}$, and $P_4 = 0.8$

$$h_2 = \frac{0.14 \times 181 \times 10^{-6}}{2.08 \times 10^{-6} \times 0.8} = 15.2$$

This means that for this instrument the pressure will have to be adjusted for each determination until an h_2 value of approximately 15.2 cm. is obtained. The h_2 value will be different with different capillary-constant values. It will be necessary to adjust the pressure difference across the apparatus for each cement to obtain the constant flow of 1/2 liter per hour. This can be accomplished by adjusting the air release valve to the proper depth. Another method is to use an aspirator bottle instead of an aspirator to apply the pressure difference. The aspirator bottle is filled with water, the suction line attached to the top opening and a 2-ft. length of rubber tubing to the bottom opening. The rubber tubing should have a piece of glass tubing slightly constricted at the terminal end. The pressure difference across the apparatus and also the rate of flow can be adjusted by adjusting the distance that the glass tip is below the level of the water in the aspirator bottle. A further refinement can be made by hanging the aspirator bottle on a spring of such strength that the level of the water in the bottle remains constant with respect to the discharge tip as the water flows out.

(*D*) Using 17-g. samples of each of the cements compact the respective samples using 10-kg. pressure on the plunger. A suggested method of doing this is to place the permeability cell and powder on a scale or balance of appropriate capacity. The plunger is then placed in the cell and the powder compacted, increasing the pressure on the plunger until the total pressure as indicated on the scale or balance is 10 kg. Omit item 4 of the testing procedure.

Measure the depth of bed or the depth to which the plunger is inserted and calculate the porosity of the bed in each case. Make permeability tests with constant pressure across the apparatus, that is, $h_1 + h_2 = 40 \pm 1$ cm. of kerosine. Also determine the index of compaction as in (*B*) above.

Results of Tests:

In submitting results of tests please report the following:

C value for capillary,
Diameter of cell,
Height of bed,
Weight sample used,
Calculated porosity,
h_1 and h_2 values,
Specific surface value (report to nearest 10 sq. cm.), and
Temperature of test

In an attempt to correct for variations in specific surface values with change in porosity, please calculate S_x by the following formula:

$$S_x = \frac{S_w(1 - E)0.833}{0.833 - E}$$

where S_x = the corrected specific surface.

Discussion of Results

A tabulation of the results obtained on cement No. 1 by the various laboratories is presented in Table I. The results as reported were averaged and in many instances recalculated. The specific surface, S_w, and index of compaction, *Ic*, values are, for most cases, the averages of duplicate determinations. Some of the values represent only one determination and others represent three or four determinations reported by the laboratory. The corrected specific surface, S_x, values were recalculated inasmuch as an error occurred in some of the instruction sheets. There are also presented the grand averages, the average variations and the percentage average variations. In the next to the last column is presented a value which is the intercept at zero surface of a line drawn through a plot of $14\sqrt{E^3 A h_1/CLh_2}$ *versus* porosity. Similar data were secured for the other cements but are not reproduced here. The averages, however, are presented in more condensed tables in the discussion of results.

Index of Compaction (Ic), Test Series B:

The values of index of compaction (Table II) as obtained in the different laboratories were in fairly good

TABLE I.—RESULTS OF TESTS ON CEMENT NO. 1.

Laboratory	Tests A and B Constant Pressure Across Apparatus 40 ± 1 cm. Kerosine														Test C ½ Liter per Hour Flow			Test D 10-kg. Compaction Force					Capillary Constant, × 10⁶	Porosity at Zero Surface	Temperature of Tests, deg. Cent.
	13-g. Sample E = 0.560				14-g. Sample E = 0.526				15-g. Sample E = 0.492				16-g. Sample E = 0.458				15-g. Sample E = 0.492			17-g. Sample						
	I_c, mm.	S_w, sq. cm. per g.	Range, sq. cm. per g.	S_x, sq. cm. per g.	I_c, mm.	S_w, sq. cm. per g.	Range, sq. cm. per g.	S_x, sq. cm. per g.	I_c, mm.	S_w, sq. cm. per g.	Range, sq. cm. per g.	S_x, sq. cm. per g.	I_c, mm.	S_w, sq. cm. per g.	Range, sq. cm. per g.	S_x, sq. cm. per g.	S_w, sq. cm. per g.	Range, sq. cm. per g.	S_x, sq. cm. per g.	I_c, mm.	E	S_w, sq. cm. per g.	Range, sq. cm. per g.	S_x, sq. cm. per g.			
No. 1	15.0	2810	10	3770	8.5	2910	10	3740	3.0	2980	10	3700	1.0	3070	10	3690	3000	10	3720	3.0	0.484	2830	10	3480	2.08	0.860	24 to 28
No. 2	15.1	2700	10	3620	8.5	2800	0	3600	3.0	2880	0	3570	1.0	2940	10	3540	2880	10	3570	2.1	0.483	2860	20	3520	3.15	0.850	25 to 28
No. 3	14.2	2750	20	3690	8.8	2860	0	3680	2.7	2940	0	3650	1.1	3020	30	3640	2960	10	3670	2.3	0.491	2900	0	3590	1.99	0.850	23 to 27
No. 4	15.6	2710	10	3640	8.7	2840	0	3650	2.5	2950	10	3660	1.0	3010	10	3620	2950	0	3660	2.3	0.488	2970	0	3670	1.94	0.825	25
No. 5	16.0	2770	40	3710	9.2	2890	40	3720	3.5	3000	10	3720	1.7	3110	20	3740	2990	20	3710	2.7	0.481	2850	30	3500	1.404	0.820	21
No. 6	...	3060	0	4110	8.5	2830	210	3640	3.0	3020	20	3750	1.5	3070	60	3690	3000	10	3720	1.5	0.483	2980	0	3670	1.95	0.770	...
No. 7	14.2	2880	40	3760	8.0	2860	10	3670	2.5	2950	20	3660	0.5	3020	0	3640	2950	20	3660	1.7	0.486	2920	150	3620	1.99	0.850	22 to 24
No. 8	15.5	2680	...	3600	10.7	2860	...	3680	3.0	3040	...	3770	1.0	3050	...	3670	2880	...	3570	1.0	0.481	2700	...	3310	2.12	0.835	24 to 25
No. 9	14.5	2800	20	3760	10.5	2920	10	3760	3.2	2980	0	3700	1.0	2880	50	3470	3010	10	3740	2.5	0.493	3130	50	3890	1.74	0.845	23 to 28
No. 10	15.4	2680	0	3600	7.2	2780	10	3580	2.7	2850	0	3540	1.0	2910	30	3500	2870	10	3560	2.2	0.485	2900	30	3570	1.93	0.855	23 to 28
No. 11	15.8	2670	20	3580	10.4	2790	20	3590	3.5	2900	20	3600	1.2	2980	40	3590	2910	30	3610	3.6	0.493	2900	70	3600	3.38	0.835	24 to 27
No. 12	13.5	2720	170	3650	7.5	2870	100	3690	3.0	2920	150	3620	1.0	2980	190	3590	2550	310	3160	2.0	0.493	3210	60	3990	1.95	0.845	...
No. 13	15.2	2840	20	3810	8.2	3010	10	3870	2.5	3110	20	3860	0.5	3190	10	3840	3120	40	3870	2.7	0.494	3010	20	3740	1.90	0.840	23 to 26
No. 14[a]	16.8	2470	20	3320	11.5	2480	140	3190	5.8	2730	60	3370	1.8	2730	10	3290	2440	380	3030	2.0	0.444	2310	140	2750	1.06		
No. 15	15.0	2830	30	3800	9.5	2960	20	3810	2.7	3050	10	3790	1.0	3120	10	3760	3050	20	3790	2.3	0.493	3140	20	3900	1.70	0.855	23 to 27
No. 16	15.0	2530	...	3400	9.3	2850	...	3670	3.5	2950	...	3660	1.5	2970	...	3580	2940	...	3650	2.2	0.499	2980	...	3730	1.812	...	24 to 27
No. 17	9.0	2660	10	3570	2.0	2760	10	3550	0.5	2800	0	3470	0	2960	10	3560	2740	...	3400	...	...	...	...	...	1.856	0.840	27 to 29
No. 18	13.8	2810	20	3770	6.8	2900	0	3730	2.7	2980	10	3700	0.9	3060	10	3680	3030	20	3760	1.6	0.484	3000	20	3700	1.51[b]	0.860	24
No. 19	15.5	2720	40	3650	8.2	2860	10	3680	3.0	2950	20	3660	1.0	2960	0	3560	2880	100	3570	2.0	0.483	2890	40	3550	1.90	0.850	26 to 38
No. 20	14.5	2920	30	3920	8.5	3140	0	4040	2.5	3060	60	3800	1.0	3240	0	3900	3090	0	3840						1.85	...	24 to 28
Avg.	14.6	2765	29	3690	8.4	2880	27	3700	2.8	2960	21	3680	1.0	3030	28	3650	2940	39	3645	2.2	0.488	2950	41	3650			
Avg. Var.	0.9	83			1.1	62			0.4	57			0.2	72			88			0.4		95		129			
Avg. Var., per cent.		3.0				2.2				1.9				2.4			3.0					3.2		3.5			
20A[b]	12.7	2610	200	...	7.0	2930	50	...	2.0	2950	0	...	1.0	3040	20		2960	0	...	...	0.493	2890	10	3600			

[a] Not included in averages.
[b] Results of retest—received too late to be included in averages.

TABLE II.—AVERAGE INDEX OF COMPACTION, MM.

Series	Weight of Sample, g.	Cement No. 1	Cement No. 3	Cement No. 4	Cement No. 5	Cement No. 6	Cement No. 7	Cement No. 8	Cement No. 9
A	12	...	...	...	...	...	11.3	...	3.8
	13	14.6	16.5	13.4	9.3	14.8	3.4	10.1	1.4
	14	8.4	14.0	5.8	3.3	7.5	1.1	3.0	0.5
	15	2.8	6.3	2.1	1.3	2.3	...	1.1	...
	16	1.0	2.3	0.7	...	...	...	...	...
D	17	2.2	2.1	2.3	1.9	2.1	1.9	2.2	2.1

TABLE III.—AVERAGE VARIATION OF INDEX OF COMPACTION, MM.

Series	Weight of Sample, g.	Cement No. 1	Cement No. 3	Cement No. 4	Cement No. 5	Cement No. 6	Cement No. 7	Cement No. 8	Cement No. 9
A	12	...	...	...	...	...	1.0	...	0.6
	13	0.9	0.5	1.0	1.7	0.9	0.6	1.4	0.5
	14	1.1	1.0	0.8	0.6	1.1	0.4	0.6	0.3
	15	0.4	1.2	0.4	0.4	0.5	...	0.4	...
	16	0.2	0.4	0.3	...	...	...	...	...
D	17	0.4	0.4	0.4	0.3	0.4	0.4	0.5	0.5

TABLE IV.—AVERAGE VALUES SPECIFIC SURFACE (S_w), SQ. CM. PER G.

Series	Weight of Sample, g.	Cement No. 1	Cement No. 3	Cement No. 4	Cement No. 5	Cement No. 6	Cement No. 7	Cement No. 8	Cement No. 9
A	12	...	...	...	...	...	4250	...	7580
	13	2765	3120	3160	5090	4070	4405	5280	7880
	14	2880	3270	3310	5265	4235	4460	5520	8020
	15	2960	3375	3420	5360	4345	...	5570	...
	16	3030	3430	3485	...	...	...	...	...
C	12	...	...	...	...	...	...	...	7520
	13	...	...	...	...	...	4395	...	...
	14	...	...	...	5260	...	...	5495	...
	15	2940	...	3425	...	4360	...	...	...
	16	...	3430	...	...	...	...	...	...
D	17	2950	3385	3385	5290	4300	4465	5465	7760

TABLE V.—S_w, AVERAGE VARIATION FROM THE AVERAGE, PER CENT.

Series	Weight of Sample, g.	Cement No. 1	Cement No. 3	Cement No. 4	Cement No. 5	Cement No. 6	Cement No. 7	Cement No. 8	Cement No. 9
A	12	...	...	...	...	...	2.6	...	2.2
	13	3.0	2.4	3.0	2.0	3.8	2.2	2.9	2.2
	14	2.2	2.2	2.6	1.7	2.3	2.4	1.8	3.9
	15	1.9	2.0	1.6	1.8	2.3	...	2.8	...
	16	2.4	2.1	2.2	...	...	...	...	...
C	12 to 16	3.0	2.0	1.8	1.8	2.5	2.4	3.0	2.3
D	17 S_w	3.2	3.0	2.9	2.6	1.9	3.5	3.8	4.2
	17 S_x	3.5	3.3	3.0	2.8	2.0	3.4	3.8	4.1

agreement with the average values. Although the variations from the averages of these values were small in terms of actual measurements (Table III) they were large in terms of percentage. The percentage variations at the greater penetrations were smaller than those at lesser penetrations. It must be remembered that the Vicat apparatus scale is not easy to read to 0.1 mm. and some of the variations were due to inaccurate readings. Some laboratories apparently had trouble with the plunger sticking and not having a free fall. A Vicat apparatus in this condition would produce erroneous results in the consistency test for cement as well.

Specific Surface (S_w), Test Series A:

Most of the laboratories reported a regular increase in specific surface values with decrease in porosity. Some of the values were erratic. The averages are presented in Table IV. The average variation from the average of the specific surface values as determined at the various porosities on each of the cements ranged from 1.6 to 3.9 per cent (Table V). Best agreement between laboratories was attained at porosities at which index of compaction values of from 2.0 to 10.0 were obtained.

Two of the laboratories located at high elevations (Nos. 2 and 10) reported S_w values considerably lower than the average. This supports the data presented by Meyers[2] that the barometric pressure effects the specific surface values. No record was made of the barometric pressures at the time of test in the cooperating laboratories. Although the temperatures of tests were reported, no significant trend was noted.

It is impossible to account for the variations of values of other laboratories. There are many possibilities such as (1) inaccurate measurements of the depth of bed, (2) air leakage of gasket or connection, (3) grinding action of plunger, or (4) jarring of cell at high porosities or incomplete compaction at low porosities, (5) inaccurate calibration of capillary flow-meter, or (6) errors of calculation.

Although, as mentioned previously, some of the results were erratic, the majority of the laboratories reported values which were either uniformly higher or uniformly lower than the average. This would indicate that a standard fineness sample could be used to advantage. The laboratories would be in better agreement inasmuch as a correction factor applied to each apparatus would correct for inaccuracies of cell measurements, differences of barometric pressure and the personal equation in the testing procedure. This is, however, not necessary for control work.

Test Series C:

The values for specific surface obtained when using a constant rate of flow of $^1/_2$ liter per hour in all laboratories (Table IV) appeared to be within experimental error of values obtained at corresponding porosities and using a constant pressure across the apparatus. Agreement between laboratories was not so good as when a constant pressure across the apparatus was used (Table V).

Test Series D:

Although the specific surface values obtained by this method agreed with those obtained in series *A* (see Table IV), the agreement between different laboratories was not so good (Table V). Apparently difficulties were encountered in accurately measuring the depth of bed. The fact that the formula for S_x did not correct for the different porosities as obtained in the different laboratories also indicates that the variations were due to errors in measuring the depth of bed.

Range:

The "range" as reported for cement No. 1 in Table I indicated that in duplicate determinations the reproducibility of the values obtained was satisfactory in most laboratories. Some of the high values represented the difference between the high and low values of 3 or 4 determinations when the values obtained in the first 2 determinations did not agree. Laboratory No. 12 lost its trained man to the draft after the first round of tests. Laboratory No. 14 used a porous filter type permeability

[2] *Rock Products*, December, 1941.

TABLE VI.—S_z USING 0.833 AS THE CONSTANT, SQ. CM. PER G.

Series	Weight of Sample, g.	Cement No. 1	Cement No. 3	Cement No. 4	Cement No. 5	Cement No. 6	Cement No. 7	Cement No. 8	Cement No. 9
	12	...	...	...	...	...	5500	...	10 080
	13	3690	4190	4250	6840	5330	5460	6760	10 040
A	14	3700	4210	4265	6780	5380	5330	6820	9 750
	15	3680	4190	4250	6650	5340	...	6670	...
	16	3650	4130	4190	...	...	...	...	...
	12	...	...	...	...	...	...	...	10 050
	13	...	...	...	...	...	5450	...	...
C	14	...	...	...	6770	...	...	6780	...
	15	3645	...	4250	...	5360	...	...	...
	16	...	4130	...	...	...	...	...	...
D	17	3650	4080	4220	6690	5280	5460	6700	10 120

TABLE VII.—S_z USING 0.850 AS THE CONSTANT.

Series	Weight of Sample, g.	Cement No. 1	Cement No. 3	Cement No. 4	Cement No. 5	Cement No. 6	Cement No. 7	Cement No. 8	Cement No. 9
	12	...	...	...	...	...	5310	...	9710
	13	3570	4020	4080	6560	5190	5310	6550	9720[a]
A	14	3580	4070	4120	6550	5210	5220[a]	6630	9580[a]
	15	3570	4070	4120	6460[a]	5190	...	6510[a]	...
	16	3560[a]	4030	4100[a]	...	...	...	...	...
Avg.		3570	4050	4105	6525	5200	5280	6560	9670
Avg. Variation		5	22	15	40	10	40	40	60
Avg. Variation, per cent		0.1	0.5	0.4	0.6	0.2	0.8	0.6	0.6

[a] Index of compaction, Ic, values of less than 2.0 with these weights of samples used.

cell and also a capillary with a small constant. However, the erratic Ic values seemed to indicate that possibly the cell and capillary were not the cause of the erratic S_w values.

The Corrected Specific Surface S_z:

The corrected specific surface (S_z) values were recalculated inasmuch as a typographical error occurred in many of the instruction sheets such that the constant 0.833 did not appear in both the numerator and denominator in the formula for S_z as was intended. Much better agreement was obtained at different porosities when using the corrected formula than with the original Lea-Nurse formula (Table VI).

In plotting the data from the reports of the cooperating laboratories it appeared that a better value for this constant would be 0.850. Using 0.850 as the constant in the formula for S_z, values were obtained at different porosities which were in better agreement with one another (Table VII). The S_z values obtained by this formula have a tendency to fall off where the index of compaction value is less than 2.0. Supplementary work has indicated that the formula holds at higher porosities than those used in this investigation. Much more care must be used, however, in preparing the bed of material when testing at the higher porosities.

Although the results of this investigation indicated an average value of 0.850 for the constant, there was a considerable scattering of results in the individual determinations of the different laboratories (see data for cement No. 1 in Table I). In 130 determinations of the constant as obtained by plotting the values submitted by the cooperating laboratories the average variation was 2.0 per cent. Values of from 0.840 to 0.860 were obtained from the averages of the laboratories. Considering the length of the extrapolation and the spread of the values from which the averages were computed, it is impossible, at this time, to say that the differences of the values of the constant obtained for the different cements are significant. Additional careful and painstaking work may indicate significant differences of this constant for different cements but, for the present, and for practical purposes, a value of 0.850 appears suitable for cement. This constant *does not* hold for all materials.

The Lea-Nurse formula for the relation of specific surface to permeability

$$S_w = \frac{14}{P(1 - E)} \sqrt{\frac{E^3 A h_1}{C L h_2}}$$

implies that values of the surface area in square centimeters per unit volume of bed as determined at different porosities, plotted against the porosity at which they were determined, should be on a straight line which intersects the zero surface line at a porosity of 1.000. The value of the intersection of this line with the zero porosity line is the specific surface in square centimeters per unit volume of solids, and this value, divided by the density of the solids in grams per cubic centimeter, is the specific surface in square centimeters per gram.

Actually, when plotting $14 \sqrt{E^3 A h_1 / C L h_2}$, which according to the Lea-Nurse formula is the square centimeter per unit volume of bed, against the porosity and a straight line is drawn through the points, this line intersects the zero surface line at a porosity of 0.850 for cements and not 1.000.

In Fig. 1 is represented a typical example of a plot of specific surface per unit volume *versus* porosity. The line AB passes through the experimentally determined values of $14 \sqrt{E^3 / A h_1 / C L h_2}$ plotted against the porosity at which determined, intersecting the zero surface line at a porosity of 0.850. The values of the intersections at zero porosity of the lines drawn from C through the experimentally determined values to points S_1, S_2, S_3, S_4, and S_5, respectively, represent the Lea-Nurse values for surface area per unit volume of solid material. Each of these values divided by the density of the powder is the value for specific surface in square centimeters per gram. The graph indicates why different specific surface values are obtained at different porosities.

Instead of taking the values represented by $S_1 \ldots S_5$ divided by the density of the powder as the specific surface of the powder in square centimeters per gram it is

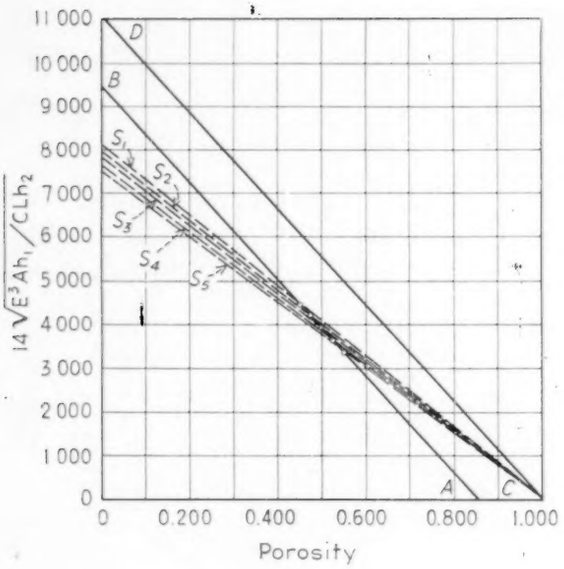


Fig. 1.

proposed that the value represented by points *B* or *D* divided by the density of the powder be used.

Point *B* divided by the density of the powder can be represented in terms of permeability and apparatus constants as per the Lea-Nurse formula as

$$\frac{0.850 \times 14}{P(0.850 - E)} \sqrt{\frac{E^3Ah_1}{CLh_2}} \quad \ldots\ldots\ldots\ldots (1)$$

and *D* divided by the density of the powder is represented by

$$\frac{14}{P(0.850 - E)} \sqrt{\frac{E^3Ah_1}{CLh_2}} \quad \ldots\ldots\ldots\ldots (2)$$

Either of these formulas results in values for specific surface in square centimeters per gram which are not affected by the porosity at which the powder is tested.

The value of the constant (0.850) is not the same for all powders. The A.S.T.M. fineness investigation indicated that for the 8 cements tested the differences of values of the constants as obtained from specific surface values of each of the cements are not significant (see Fig. 2). In supplementary work on other materials different values have been obtained for the constant.

For portland cements and materials of similar nature it is proposed that Eq. 2 be used and that for other materials the intersection of a line drawn through a plot of the experimentally determined values of square centimeters per unit volume of bed *versus* porosity or the calculated intersection at the zero surface line be substituted for the constant 0.850 of Eq. 2.

Conclusions

With reference to the purpose of the tests as outlined in the first part of this report the conclusions are summarized as follows:

1. There was better agreement between laboratories when cements were tested at a porosity at which an index of compaction of from 2.0 to 10.0 mm. was obtained than when tested at either higher or lower porosities.

2. Agreement between laboratories was better when using a constant pressure across the apparatus than when using a constant rate of flow of $^1/_2$ liter per hour with all samples. The specific surface values obtained when using the $^1/_2$ liter per hour flow were very nearly the same as obtained when using a constant pressure across the apparatus.

3. The index of compaction test showed promise of great usefulness in judging the proper degree of compaction. Variations in terms of percentage were large.

4. The use of a 10-kg. compressive force to compact the cement resulted in less agreement between laboratories than was obtained by other methods. This was probably due to the difficulty of accurately determining the porosity.

There is a need for a standard sample to furnish a correction factor to compensate for errors in measurement and the personal equation in testing.

A change in the Lea-Nurse formula has been proposed by which the values as obtained for specific surface are more nearly the same regardless of the porosity at which determined.

Acknowledgment:

Appreciation is expressed to the personnel of the laboratories for their helpful cooperation in this investigation.

Acknowledgment is made to R. L. Blaine of the National Bureau of Standards staff for the compilation of the data submitted by the cooperating laboratories as well as for the study of the data and the preparation of this report.

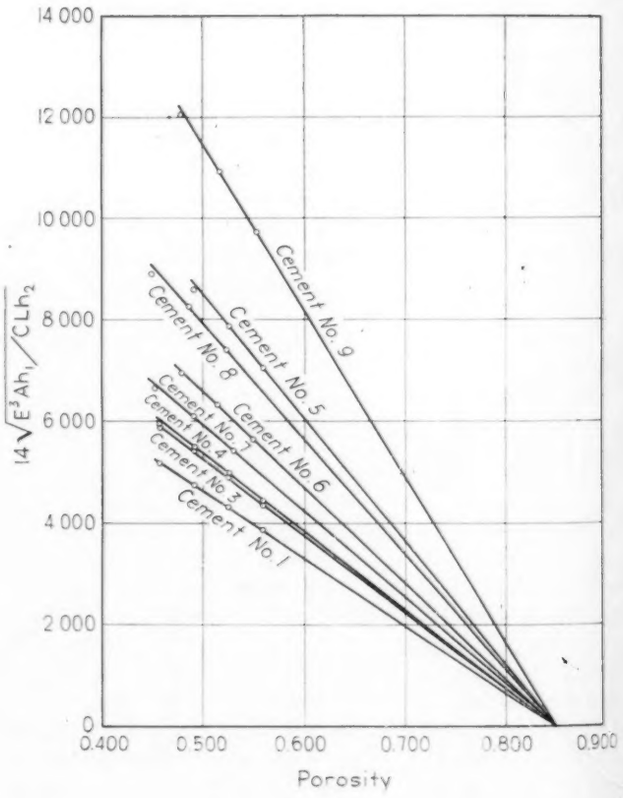


Fig. 2.

Effect of Size of Specimen in Studies of Durability of Concrete as Affected by Aggregates

By Stanton Walker[1] and Fred F. Bartel[1]

FREEZING-AND-THAWING tests of concrete are finding wide acceptance as means for determining the suitability of aggregates for use in concrete exposed to weathering. Investigations show such tests to offer outstanding promise.[2] For them to be of maximum usefulness, testing procedure must be standardized and test results must be correlated with service records.

Standardization of testing procedure involves control of many different factors. Without attempting a complete tabulation of them, the following may be mentioned as among those deserving consideration:

1. Temperature to which specimens are frozen.
2. Rate of freezing.
3. Temperature to which specimens are subjected in thawing.
4. Rate of thawing.
5. Quality of concrete as affected by proportions, curing, age at test, etc.
6. Moisture condition of specimen.
7. Size of specimen.

These and other factors affect the resistance of concrete specimens to freezing and thawing.

At the National Sand and Gravel Association Research Foundation at the University of Maryland, studies are being made of concrete durability as affected by aggregates. In the course of that work, some information is being developed on factors related to the standardization of freezing-and-thawing test procedure. The present paper presents some exploratory tests on the effect of concrete test specimens in studies of coarse aggregates. It seemed reasonable to suppose that the mortar matrix would afford less protection to the coarse aggregate in small specimens than in larger ones.

Outline of Tests

Three sizes of beams were subjected to freezing and thawing: 3 by 3 1/2 by 14 in.; 3 by 4 by 16 in.; and 5 by 6 by 20 in. For routine determination of compressive strength, 4 1/2 by 9-in. cylinders were made; ends of broken beams of the smallest size were also tested in compression as "modified cubes."

Three gravel coarse aggregates were selected because earlier tests had shown that they would contribute to the breakdown of the concrete. Two of them were chert gravels incorporated in the concrete in both a stream-wet condition (that is, as they came from the under-water deposit) and after drying and subsequent immersion in water for 24 hr. The third was a river gravel, containing considerable unsound material, which was saturated under vacuum before being incorporated in the concrete.

The gravel was graded from 1 in. to No. 4; 25 per cent from 1 to 3/4 in., 50 per cent from 3/4 to 3/8 in., and 25 per cent from 3/8 in. to No. 4 for the two chert gravels; and, because of sizes available, 21, 58, and 21 per cent, respectively, for the river gravel. The concrete contained 5.5 sacks of cement per cubic yard and enough water (water-ratio 0.68 by volume) to result in a flow[3] of 80 to 90 per cent (slump about 3 to 4 in.). The same sand was used throughout. The ratio of sand to total aggregate, by absolute volume, was 44 per cent which resulted in a fineness modulus of 5.2. The sand was well graded, having about 17 per cent passing a No. 50 sieve and a fineness modulus of 2.94. Specific gravities and absorptions of the aggregates are shown in Table I.

TABLE I.—SPECIFIC GRAVITY AND ABSORPTION OF AGGREGATE.

Lot	Kind of Aggregate	Absorption, per cent		Bulk Specific Gravity (dry basis)
		24 hr.	Stream-Wet	
No. 1364.....	Chert gravel	1.7	2.6	2.47
No. 1376.....	Chert gravel	3.6	5.4	2.28
No. 1551.....	River gravel	1.8	3.5[a]	2.53
No. 1552.....	Sand	1.46	...	2.58

[a] Saturated under vacuum.

Eight specimens were fabricated from each batch; one 4 1/2 by 9-in. cylinder, three of the smallest size beams, and two each of the larger size beams. The cylinder and one of the 3 by 3 1/2 by 14-in. beams were used for routine deter-

[3] Standard Method of Test for Flow of Portland-Cement Concrete by Use of the Flow Table (C 124 – 39), 1939 Book of A.S.T.M. Standards, Part II, p. 337.

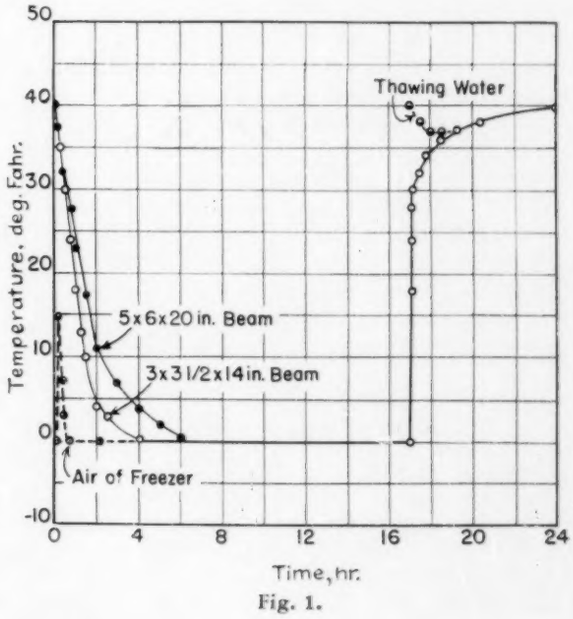


Fig. 1.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia, Pa.

[1] Director of Engineering, and Associate Engineer, respectively, National Sand and Gravel Assn., Washington, D. C.

[2] See Thesis by Fred F. Bartel on "Effect of Aggregate Characteristics on Durability of Concrete," and list of references appended thereto, presented to Graduate School, University of Maryland, in partial fulfillment of the requirements for degree of Master of Science.

TABLE II.—CONTROL TESTS OF CONCRETE.

Lot of Aggregate	Moisture in Aggregate, per cent	Strength After 28 Days Standard Curing, psi.		
		Compression		Flexure (3 by 3½ by 14-in. beams)
		Cylinder	Modified Cubes	
No. 1364.	2.6 (stream wet)	4150	5210	830
	1.7 (soaked 24 hr.)	4270	5340	775
No. 1376.	5.4 (stream wet)	3740	4520	680
	3.6 (soaked 24 hr.)	3930	5050	755
No. 1551.	3.5 (vacuum saturated)	4070	5140	670

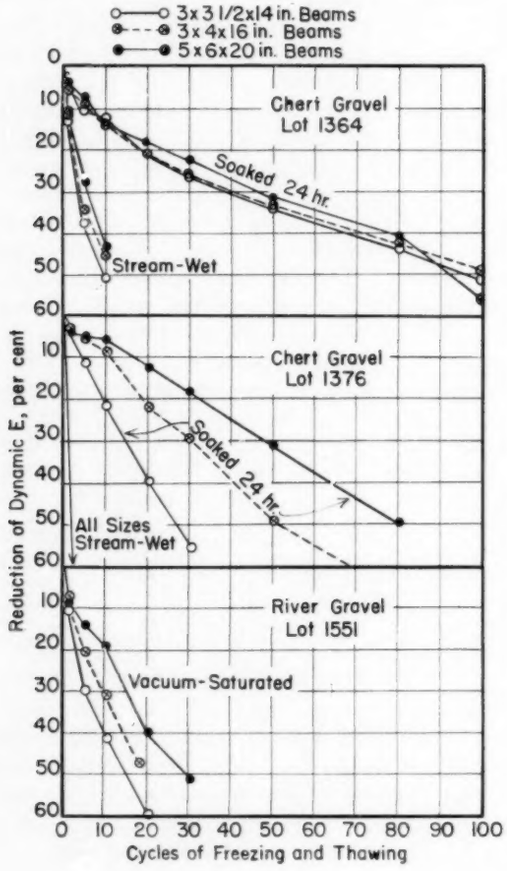


Fig. 2.

minations of strength after 28 days' curing in the moist room. One beam of each size from each batch was subjected to freezing and thawing and a second was cured in the moist room until freezing and thawing were discontinued on its companion specimen. At that time both beams were tested for strength in flexure. Three specimens were made on different days for each condition of test. The freezing-and-thawing cycle consisted of storage of the specimens for 17 hr. in air at 0 F., followed by 7 hr. in water at 40 F. The characteristics of this cycle are shown in Fig. 1. The specimens, before being subjected to freezing and thawing, were cured for 28 days in the moist room at 70 F. and 28 days in water at room temperature.

Modulus of elasticity, measured dynamically, was used as the principal measure of the resistance of the concrete to freezing and thawing; strength tests were also made. The dynamic modulus was calculated in accordance with the formula reported by Obert and Duvall:[4]

$$E = \frac{4\pi^2 L^4 f^2 \rho}{m^4 k^2} T$$

where E = modulus of elasticity in pounds per square inch,
L = length of specimen in inches,
f = frequency in cycles per second,
ρ = density in mass units in slugs per cubic inch,
m = 4.73 (a numeric for fundamental frequency),
k = radius of gyration of the section about an axis perpendicular to the plane of bending in inches, and
T = a correction factor depending upon L/k and Poisson's ratio.

T was taken as 1.28 for the 3 by 3½ by 14-in. beams, 1.22 for the 3 by 4 by 16-in. beams, and 1.38 for the 5 by 6 by 20-in. beams.

Preparation and Testing of Specimens

In general, standard procedures were followed in molding and testing the specimens. Beams were loaded at the

[4] Leonard Obert and Wilbur I. Duvall, "Discussion of Dynamic Methods of Testing Concrete with Suggestions for Standardization," *Proceedings*, Am. Soc. Testing Mats., Vol. 41, p. 1053 (1941).

TABLE III.—SUMMARY OF FREEZING-AND-THAWING DATA.

Size of Beam, in.	Modulus of Elasticity, E, Before Test[a]	Number of Cycles		Loss, per cent	
		Total	At 50 per cent Loss in E	Modulus of Elasticity	Flexural Strength
Chert Gravel, Stream-Wet, Lot 1364					
3 by 3½ by 14	5.81	10	10	51	66
3 by 4 by 16	6.04	15	13	57	66
5 by 6 by 20	5.58	15	13	54	57
Chert Gravel, Soaked 24 hr., Lot 1364					
3 by 3½ by 14	6.00	100	100	49	60
3 by 4 by 16	5.91	100	100	51	60
5 by 6 by 20	5.32	100	92	56	56
Chert Gravel, Stream-Wet, Lot 1376					
3 by 3½ by 14	5.21	1	...	77	82
3 by 4 by 16	5.00	1	...	75	67
5 by 6 by 20	4.73	1	...	68	79
Chert Gravel, Soaked 24 hr., Lot 1376					
3 by 3½ by 14	5.13	32	27	56	87
3 by 4 by 16	5.13	80	51	68	65
5 by 6 by 20	4.85	80	80	50	67
River Gravel, Vacuum Saturated, Lot 1551					
3 by 3½ by 14	5.81	20	15	60	77
3 by 4 by 16	5.74	18	20	47	65
5 by 6 by 20	5.50	30	30	51	64

[a] Determined dynamically, values are $10^{-6} \times E$, psi.

center point in the flexure tests. Load was applied, and the beams were vibrated for the dynamic modulus tests, at right angles to the position of molding. The forms for the 3 by 3 1/2 by 14-in. beams were of wood and were rested on a metal-top table during the molding process; the forms for the other sizes of beams were of metal and were substantially watertight. All surfaces of all molds coming in contact with the concrete were coated with a thin layer of mineral oil. The freezing-and-thawing tests and the determination of modulus of elasticity by dynamic methods were performed with the equipment and in the manner used by this laboratory and described in the Bartel thesis referred to earlier.

Discussion of Test Results

The test data are summarized in Tables II and III and Fig. 2. Table II gives the control tests of concrete; Table III and Fig. 2 summarize the freezing-and-thawing tests.

It will be seen from Table III and Fig. 2 that the effect of size of specimen varied with the aggregate and with the condition of the aggregate. In all cases the large specimens performed in a manner similar to the small ones, but in some cases the breakdown was slower. For the partially saturated chert gravels (dried and then immersed in water for 24 hr. before being incorporated in the concrete) the larger specimens showed somewhat better resistance, particularly in the case of the more absorptive of these two gravels; this was probably due to the greater resistance offered to the passage of water to aggregate particles near the center of the specimen. The increased resistance was probably a function of the distance which the free water needed to travel before being absorbed by the aggregate particles. The stream-wet aggregates, which were completely saturated with water, were afforded little or no protection by the larger masses of concrete.

In the case of gravel lot 1551, which contained unsound aggregate as a minor constituent, the mass of the larger specimens appeared to exert a restraining action on the deleterious particles. Had this aggregate been dry, or only partially saturated, when made into concrete, the beneficial action of the larger unit of concrete would probably have been more pronounced.

Reference to Table III will show that the relationships between loss in modulus of rupture and loss in modulus of elasticity, determined dynamically, follow quite well similar relationships established previously by Reagel[5] and by Bartel,[2] without regard to the size of specimen. Table III also shows that lower moduli of elasticity, determined dynamically, were found for the large beams than for the small ones; this phenomenon is in agreement with data reported by Obert and Duvall.[4]

These tests on chert gravel confirm more comprehensive tests from this laboratory[2] and from other laboratories which show that the degree of saturation of the gravel greatly influences the resistance to freezing and thawing of the concrete in which it is used. The stream-wet material broke down comparatively rapidly. The partially saturated material showed resistances comparable to those obtained from aggregates of known good service record.

[5] F. V. Reagel, "Freezing and Thawing Tests of Concrete," *Proceedings*, Highway Research Board, Vol. 20, p. 587 (1940).

200 at Philadelphia Meeting on Timber

Upwards of 200 A.S.T.M. members, guests, and visitors heard a very interesting and instructive talk on "Recent Progress in Timber Research" presented by L. J. Markwardt, Chief, Division of Timber Mechanics, Forest Products Laboratory, Madison, Wis., at a meeting sponsored by the Philadelphia District Committee at the Franklin Institute on September 24. An outstanding authority in this field and a long-time A.S.T.M. member, Mr. Markwardt with excellent illustrations and numerous exhibits treated this broad subject in a way that the interest of everyone was maintained throughout. F. G. Tatnall, Baldwin-Southwark Corp. and Chairman of the Philadelphia group, presided at the meeting and stimulated discussion in his usual interesting manner. Prior to the technical session about 50 of the members and visitors enjoyed an informal dinner together.

This meeting, a most successful one, marked the beginning of a rather extensive program for the local committee. The District Committee will join with two other societies for October and November meetings and then will sponsor its own meetings in January, February, and March. Information concerning these meetings will be given in succeeding Bulletins.

Since it is planned to publish Mr. Markwardt's paper in view of its broad interest, only brief notes on his talk are given here. Following a discussion of microstructure in which he outlined the fibrous structure mentioning that the fiber is made up of cellulose comprising about 60 per cent of the wood, lignin 28 per cent, and sugars and extractives the other 12 per cent, he then went on to discuss a most interesting development, namely, chemical seasoning which not only reduces losses in large timbers to checking and cracking from as much as 40 to 60 per cent to 5 per cent, but also decreases drying time. He discussed various types of metal connectors and also illustrated the used of laminated arches. He spent considerable time covering resin impregnated wood, termed "impreg" and "compreg." He stressed the fact that when veneer is impregnated with certain resin materials and made into plywood or laminated constructions, the material can be compressed at the same time the resin is setting. The resulting product has a very high modulus of rupture of 43,450 psi., a tensile strength of 42,550 psi., and a modulus of elasticity of 4,418,000 psi.

He referred to the development of wood plastics and laminated paper plastics and demonstrated many of the forms in which timber can be furnished. Following his remarks, there was an examination of the specimens and an informal question and answer period.

War Posters

Members of the Society who wish to receive copies of posters designed to stimulate production and morale can obtain these by contacting the Division of Information, Office for Emergency Management, Room 200, 1516 14th St., N. W., Washington, D. C. The Office of War Information is anxious that these posters shall be put to most effective use.

ASTM Bulletin

OCTOBER 1942

NO. 118

TWO-SIXTY
SOUTH BROAD ST.
PHILADELPHIA, PENNA.

Relentless Tester

War—Relentless Tester of Materials—is the caption of a prominent steel company's advertisement. Indeed many things are being tested relentlessly by the present war; the very foundations of democracy itself. We frankly like the phrase "relentless tester"—perhaps selfishly, because war has focused attention on the necessity of constant and continued evaluation of materials. It is not correct to say that testing is coming into its own because it naturally was on the increase with industrial progress. It is a part of materials progress. War is a relentless materials tester; it is also a tester of men, particularly today of the technical men and engineers who must as never before be on the alert to the necessity of conservation and substitution; making twice as little go twice as far and justifying a use of every critical and strategic material.

Many institutions are being put to the "acid" test today; many will need to alter their objectives, worthy enough, perhaps, in time when stress isn't so high; others including many of the leading technical and engineering societies are meeting the test and rendering efficient and worth-while service.

In connection with the development of standard specifications and test methods, the use of the Society's standards is markedly on the increase. There are numerous examples of standards use in this BULLETIN including a new Canadian National Building Code. The continued close cooperation of members and committee members in pushing forward both research and standardization work is in itself an evidence of the worthwhileness of our activities.

Increased Membership

DUE TO THE CONTINUED interest and cooperation of many members of the Society and to the natural accretion of new members who having learned of the Society through its publications or otherwise are desirous of becoming affiliated with it, we are able to report very encouraging statistics on the membership picture as of September 30. It will be noted that 96 new memberships are reported in the later pages of this BULLETIN which is larger than normal. On September 30, 1942, the total membership was 4677 compared with the 1941 figure of 4490, a net gain of 187. The total number who have joined the Society either as company, individual, or other classes of new members since the beginning of the year is 372. Meanwhile there have been some deaths, transfers, and resignations, and some members dropped for nonpayment of dues, a large proportion of these being memberships held in foreign countries—Belgium, Holland, Italy, Germany, France, etc.

Adding to the regular membership the number of students affiliated with A.S.T.M., totaling on September 30, 518, it is seen there are well over 5000 organizations and individuals affiliated with A.S.T.M. On September 30, there were 149 sustaining members (all companies or corporations), almost 1100 company members, and over 3400 individual and junior members including library, municipal and state departments, and related memberships that pay the same dues as for individuals. Thus about one-quarter of the A.S.T.M. members are company or corporation members.

Some time ago in connection with another study, approximate figures were developed showing the percentage of members in executive and related capacities. It was not surprising to find that approximately 55 per cent of the A.S.T.M. members were covered in the engineering and technical personnel classification; about 16 per cent, were listed as manufacturing personnel, works managers superintendents, etc.; and about 16 per cent were presidents, vice-presidents, secretaries, assistants to presidents, etc., the balance being in other classifications—consulting engineers, libraries, government departments, and the like.

The Executive Committee's membership group is desirous that the advantages of affiliation with the Society be as widely known as possible, and it is appreciative of the very helpful cooperation which many A.S.T.M. members render in connection with membership promotion. There are many men who for several years have persuaded a number of new members to join with the Society and who when asked to "follow up" an individual or company which might benefit from affiliation with A.S.T.M. have never failed. In the near future it is planned to mail to each A.S.T.M. member a new folder entitled "About the American Society for Testing Materials" and a membership application blank which it is hoped each will distribute to some business associate or acquaintance.

The year 1942 is, of course, one of the best in which to become affiliated with A.S.T.M. in view of the appearance of the new 1942 Book of Standards. The extensive volume of *Proceedings* is furnished, the BULLETIN is of course sent (new members joining in October and November get three back issues of the BULLETIN), and in general the very liberal publication distribution policy is effective. A larger number of members means that the Society is able to furnish extensive publications to the members and still maintain a reasonably conservative financial standing.

The Society officers and administrative staff have never advocated so-called membership drives, but have felt that the value of A.S.T.M. work and advantages of membership, plus the sustained interest of the existing members would be the wisest plan in the long run, and it is encouraging to be able to report the continued wisdom of this policy.

1943 Spring and Annual Meetings

PITTSBURGH has been selected as the location of the 1943 annual meeting, the Executive Committee at its meeting on October 13 accepting the cordial invitation extended by the Pittsburgh District Committee. Meetings will be held during the week beginning Monday, June 28. Reservations have been made at the William Penn Hotel, now under Statler management. The Meetings Committee considered at length the effect of the war emergency on travel facilities, and having in mind that the approximate center of gravity of A.S.T.M. membership is near Pittsburgh, it felt that this would be a logical place. Furthermore, this area, a very strong materials center, has many industries which are vitally concerned with the work of the Society, notably, of course, iron and steel, and it seemed appropriate to hold an annual meeting in this location.

Also a decision was reached not to hold the commercial exhibit of testing apparatus and related equipment customarily held at two-year intervals in the odd years. Some non-commercial research and testing displays may be arranged.

1943 Spring Meeting and Committee Week.—As previously announced, this meeting will be held in Buffalo, N. Y., during the week of March 1. A Buffalo Committee on Arrangements is being developed which will include a number of members serving on the new Western New York-Ontario District Committee, organization of which will be announced in the December BULLETIN. Mr. B. L. McCarthy, Wickwire Spencer Steel Co., who has been appointed temporary chairman of the District Committee, is serving as chairman of the Committee on Arrangements and serving with him will be a number of active A.S.T.M. members and committee members in this area.

Favorable 1942 Standards Letter Ballot

A CANVASS ON SEPTEMBER 1 of the 1942 letter ballot on recommendations affecting A.S.T.M. standards showed all items on the ballot adopted. There were 139 actions covered—one a new standard covering hardness conversion table for cartridge brass; 94 revisions of existing standards were adopted for incorporation this year, and 44 previously existing tentative standards were adopted as formal standards. Over 485 votes were cast and while in accordance with previous practice no record of the returns will be published; any member of the Society who wishes to have the vote on a particular item can obtain this information from A.S.T.M. Headquarters.

All of the new and revised standards will appear in the 1942 Book of A.S.T.M. Standards. In many cases previous to the publication of the books (late November and December) separate reprints of many of the specifications and tests will be available and a number of them will be incorporated in special compilations of standards which are described in the new pamphlet "List of Publications" and "Members' Order Blank" which has been sent to members. Several of these compilations will be published before the Book of Standards.

Wanted: Copies of the 1939 Book of Standards

Society Headquarters is in need of Parts I, II, and III of the 1939 Book of Standards. The edition, printed in 1939, was expected to be large enough to meet all requirements with a small surplus, but the unusually heavy demands for the book, especially during the current year from contractors on Government projects and from industry generally have been so great that the stock is exhausted and there are a number of urgent orders to be filled. The Society accordingly is willing to purchase copies to meet the demand until the 1942 Book becomes available. Any member willing to dispose of his copies is asked to communicate with Headquarters.

Offers of Papers for 1943

COMMITTEE E-6 on Papers and Publications in anticipation of developing the program for the 1943 Annual Meeting is desirous that members of the Society and others who have in mind submitting offers of technical papers should send these offers to Society Headquarters well in advance of the February meeting of the committee. All offers must be accompanied by a summary which should make clear the intended scope of the paper and indicate features that, in the opinion of the author, will justify its inclusion in the annual meeting program. Suitable blanks to be used in transmitting the necessary information will be sent promptly on request.

Federal Specifications for Soap

AN IMPORTANT FEDERAL specification, of interest to many members and committee members, is the one covering soap and soap products; general specifications (methods for sampling and testing) P-S-536a, dated June 25, 1942, and superseding P-S-536 issued March 4, 1937. A numerical index is helpful in locating various test methods. A reference in the specification is of interest indicating that except for three items (qualitative test for sugars, solubility and sudsing of soft soap, and sieve tests) the methods essentially correspond in technical details with standard methods issued by the American Chemical Society, the American Oil Chemists' Society, and the American Society for Testing Materials. In A.S.T.M. this work is the responsibility of Committee D-12. Copies of this Federal specification can be obtained from the Superintendent of Documents, Washington, D. C., at 10 cents.

A CORDIAL INVITATION is extended to all who are concerned with engineering materials to become members of the Society. Membership is the most feasible way of following the work closely and of obtaining regularly some of the most important materials' publications—Book of Standards and Index, Volume on Chemical Analysis of Metals, *Proceedings*, ASTM BULLETIN (6 times yearly), Year Book and special publications.

Joint Committee on Filler Metal Organized—Sponsored by American Welding Society and A.S.T.M.

Committee Personnel Has Leading Authorities Responsible for Specifications

In order better to coordinate the work in developing specifications for filler metal and to avoid overlapping activities, a new Joint Committee on Filler Metal was organized at the A.S.T.M. annual meeting on June 22, under the sponsorship of the American Welding Society and A.S.T.M. At this meeting a number of personnel details were reviewed, officers were elected, subcommittees designated, and a number of existing specifications and others in prospect were referred to the groups which have jurisdiction.

For a number of years, A.S.T.M. Committee A-1 through its Subcommittee XXI (formerly on steels for welding but later with its scope confined to filler metal) had been actively concerned with standard specifications for these materials, and the A.W.S. Filler Metal Specifications Committee also had been working in close cooperation with the A.S.T.M. group. As a matter of fact, J. H. Deppeler of the Metal & Thermit Corp., was chairman of each of the committees and there were many men on both groups. Until the work of the A.W.S. group extended beyond the field of iron and steel, difficulties which came up were easily reconciled. However with the development of standards for aluminum and aluminum alloy filler metals and the prospect of standards covering high alloy steel and nickel filler metal, it was obvious that the A.S.T.M. setup would involve contacts with different groups in both the "A" and "B" committees. Consequently, a decision was reached by the A.S.T.M. Executive Committee and the Welding Society to organize a joint committee and to concentrate work in this field in the one group.

It is expected that a number of the A.S.T.M. standing committees will appoint representatives, some already having done so. Committee A-1 on Steel, with its Chairman, Mr. Mochel and many other members active, has not designated a formal representative.

The officers of the committee as chosen in Atlantic City are as follows:

Chairman: J. H. Deppeler, Metal & Thermit Corp.
Vice-Chairman: R. W. Clark, General Electric Co.
Vice-Chairman: R. D. Thomas, N.E.M.A.
Secretary: L. M. Dalcher, American Welding Society

The Advisory Committee consists of these officers, the chairmen of subcommittees as indicated below, plus other members as approved by the main committee. Mr. Mochel was also elected an Advisory Committee member.

Subcommittees

After considering various problems which would need to be studied and fields of work which were covered in the A.W.S. Filler Metal Committee setup, the following five subcommittees were agreed on and chairmen appointed:

Joint Committee on Filler Metal

(Joint Committee of A.W.S. and A.S.T.M.)

P Air Reduction Sales Co.; J. J. Crowe
P Allis-Chalmers Manufacturing Co.; J. T. Jarman
P Aluminum Co. of America; G. O. Hoglund
P American Brass Co., The; J. R. Freeman, Jr.
GI American Bureau of Shipping; David Arnott and J. L. Wilson
C American Car and Foundry Co.; J. W. Sheffer
P American Chain and Cable Co., Inc.; W. H. Bleecker
C American Institute of Steel Construction; F. H. Frankland
P American Rolling Mill Co., The; A. E. Taylor
P American Steel and Wire Co.; L. H. Dunham
GI American Welding Society; L. M. Dalcher (Secretary)
P Arcrods Corp.; J. H. Humberstone
C Babcock & Wilcox Co., The; H. J. Kerr
C Baldwin Locomotive Works, The; A. J. Raymo
P Bethlehem Steel Co., Inc.; L. H. Winkler
C Bethlehem Steel Co., Inc., Division of Fabricated Steel Construction; Jonathan Jones
C Blaw-Knox Co.; G. M. Croft
P Carnegie-Illinois Steel Corp.; L. C. Bibber
C Carpenter, Allan W. (New York Central R. R. (Buffalo & East))
P Carpenter Steel Co., The; B. H. DeLong
P Central Iron and Steel Co.; W. F. Zerbe
Champion Rivet Co.; T. P. Champion
C Chapman Valve Co.; V. T. Malcolm
C Chesapeake & Ohio Railway Co., The; Crosby Miller
C Chicago Bridge and Iron Co.; H. C. Boardman
C Chicago Milwaukee, St. Paul & Pacific Railroad Co.; C. E. Morgan
C Combustion Engineering Co., Inc.; A. C. Weigel
C Dow Chemical Co., The; H. W. Schmidt
P Driver-Harris Co.; F. E. Bash
C du Pont de Nemours and Co., Inc., E. I.; M. H. Brown
GI Gailor, C. F. (Consulting Engr.)
C General Electric Co.; R. W. Clark
C Gulf Oil Corp.; F. C. Braun
GI Hall, J. H. (Consulting Engr.)
P International Nickel Co., Inc., The; O. B. J. Fraser
GI Jenks, G. F.
C Kellogg Co., The M. W.; J. E. Bechtle
P Lincoln Electric Co., The; J. F. Lincoln and E. W. P. Smith
C Mathieson Alkali Works, Inc., The; C. S. Glenn
P Maurath, Inc.; G. A. Maurath
P McKay, Co., The; J. C. McKay
GI Mellon Institute of Industrial Research; Daniel Neuman
P Metal and Thermit Corp.; J. H. Deppeler (Chairman)
P National Electrical Manufacturers Assn.; R. D. Thomas
C Pennsylvania Railroad Co., The; L. B. Jones
P Pittsburgh Steel Co.; T. G. Stitt
P Reid-Avery Co.; M. E. Reid
P Republic Steel Corp.; J. A. Smail and V. W. Whitmer
P Roebling's Sons Co., John A.; Dartrey Lewis
C Smith Corp., A. O.; J. J. Chyle; and C. W. Wheatley
C Standard Oil Development Co.; F. C. Fyke
C Steel and Alloy Tank Co.; C. R. Vincent, Jr.
GI Steel Founders' Society of America; C. W. Briggs
C Struthers-Wells Co.; L. H. Johnson
C Sun Oil Co.; A. B. Bagsar
P Union Carbide and Carbon Research Laboratories, Inc.; J. H. Critchett
C U. S. Army, Air Corps
C U. S. Army, Ordnance Dept.
C U. S. Army, Ordnance Dept., Rock Island Arsenal; W. W. Schmidt
C U. S. Naval Gun Factory; W. E. McKenzie
C U. S. Navy, Bureau of Ships
P Universal-Cyclops Steel Corp.; Frank Garratt
P Vanadium Corporation of America; A. W. Demmler
C Vogt Machine Co., Henry; Archibald Hurtgen
C Wellman Engineering Co.; J. C. Hodge
C Westinghouse Electric and Manufacturing Co.; N. L. Mochel
P Wheeling Steel Corp.; V. W. Bihlman

I. Iron and Steel Arc Welding Electrodes
J. H. Deppeler (Chairman)
II. Iron and Steel Gas Welding Rods
J. H. Critchett, (Chairman)
III. Aluminum and Aluminum Alloy Filler Metal
G. O. Hoglund (Chairman)
IV. High Alloy Steel Filler Metal
R. D. Thomas (Chairman)
V. Nickel and Nickel Alloy Filler Metal
O. E. J. Fraser (Chairman)

Complete personnel of these subgroups will be appointed by the Chairmen of the Joint Committee with the advice of the Advisory Committee. The appointment of two proposed committees on copper and copper alloy filler metal, and hard facing filler metal will be studied.

Specifications

Two existing specifications for which the Joint Committee took over responsibility cover iron and steel arc welding electrodes (A 233) and iron and steel gas-welding rods (A 251). Another specification which had been approved by the A.W.S. group covers aluminum and aluminum alloy metal arc welding electrodes. All three of these items are included in the 1942 Welding Handbook; the first two are issued jointly by A.S.T.M. and A.W.S. A fourth proposed standard covering stainless steel arc welding electrodes was published for information and comment in the August issue of the A.W.S. *Journal*.

Personnel

The personnel of the committee as agreed upon at the organization meeting included leading producers of the material and many consuming interests, with several consultants and general interests. The individuals who are now serving are indicated on the preceding page.

National Emergency Steel Work on Heavy Forgings

Important progress has been made by the Technical Advisory Committee on Heavy Steel Forgings headed by Clarence J. Boyle, General Electric Co., which group functions under the National Emergency Steel Specifications Work directed under WPB auspices by C. L. Warwick, with the American Iron and Steel Institute, Society of Automotive Engineers and A.S.T.M. as sponsors. Details of this work, with the personnel of a number of the advisory committees on structural steel, piping and tubular products, rails and track accessories, concrete reinforcement bars, etc., have appeared in various ASTM Bulletins.

Eight proposed emergency specifications have been developed by the committee whose scope includes "heavy carbon and alloy steel forgings produced directly from ingots or from rolled or forged billets approximating 100 sq. in. in cross-section and over. Excluded from the scope are all railroad forgings."

These proposed specifications cover the following:

Carbon-Steel and Alloy-Steel Blooms, Billets, and Slabs for Forgings
Turbine Shafts and Rotors
Turbine Generator Rotors and Shafts
Turbine Bucket Wheels
Non-Magnetic Coil Retaining Rings
Magnetic Steel Retaining Rings
Ring Forgings for Main Reduction Gears
Pinion Forgings for Main Reduction Gear Units

It will be noted that the specifications cover products that are extremely significant in the War Emergency. One of the principal objects underlying the specifications was to have the manufacturers and purchasers agree on simplified lists of compositions and also to standardize on testing requirements and properties so that increased production could result. Already there have been tangible results from this work in expediting production.

The committee has held a series of meetings, notably at the A.S.T.M. annual meeting, with a splendid spirit of cooperation. This field is one in which standardized requirements were not previously available, but, of course, those participating had the benefit of a great deal of experience particularly in connection with Navy work.

It is the intention to recommend the specifications to the NESS Administrative Committee, and the A.S.T.M. will probably issue the specifications in the near future as emergency standards following approval in its Committee A-1 on Steel. The following list of personnel indicates the outstanding metallurgical and technical authorities participating in the work and the titles of the sections will indicate some of the fields being covered. It is expected recommendations will be forthcoming from these sections.

Personnel of Technical Advisory Committee on Heavy Steel Forgings—TAC 16

Scope: Heavy carbon and alloy steel forgings produced directly from ingots or from rolled or forged billets approximating 100 sq. in. in cross-section and over. Excluded from the scope are all railroad forgings.

Chairman: C. J. Boyle, Works Laboratory, General Electric Co., Schenectady, New York

Government:

Representing the *Navy Department*
R. Wiley; Associate Engineer, Room T5-2717, Navy Dept. Bldg., Washington, D. C.
Alternate: C. E. Margerum; Senior Metallurgical Engineer, Bureau of Ordnance, Room 4147, Navy Bldg., Washington, D. C.
Representing the *War Department*
E. L. Hollady; Specification Section Office of Chief of Ordnance, Room 2E-433, Pentagon Bldg., Arlington, Va.

Industrial Consumers and General Interests

R. C. Allen; Chief Engineer, Steam Turbine Dept., Allis-Chalmers Manufacturing Co., West Allis, Wis.
F. R. Benson; Chief Engineer, Newport News Shipbuilding and Drydock Co., Newport News, Va.
C. J. Boyle; Works Laboratory, General Electric Co., Schenectady, N. Y.
T. E. Eagan; Chief Metallurgist, The Cooper-Bessemer Corp., Grove City, Pa.
Isaac Harter; Vice-President, Babcock & Wilcox Co., 85 Liberty St., New York, N. Y.
Geo. Jessop; Chief Engineer, Morgan Smith Co., York, Pa.
G. McConechy; Chief Engineer, Sun Shipbuilding and Dry Dock Co., Chester, Pa.
J. B. McDermet; Chief Engineer, Elliott Co., Jeanette, Pa.

N. L. Mochel; Manager, Metallurgical Engineer, Westinghouse Electric and Manufacturing Co., Lester Branch, P. O., Philadelphia, Pa.
F. H. Pennell; Chief Metallurgist, De Laval Steam Turbine Co., Trenton, N. J.
G. W. Place; American Bureau of Shipping, 47 Beaver St., New York, N. Y.
D. B. Rossheim; Chief Engineer, Fabricated Products Div., M. W. Kellogg Co., 225 Broadway, New York, N. Y.
B. F. Shepherd; Chief Metallurgist, Ingersoll-Rand Co., Phillipsburg, N. J.
P. V. Tippet; Farrel-Birmingham Co., Inc., Ansonia, Conn.
H. C. Waldron; General Foundry Superintendent and Metallurgist, Nordberg Manufacturing Co., Milwaukee, Wis.
A. C. Weigel; Vice-President, Combustion Engineering Co., 200 Madison Ave., New York, N. Y.
E. J. Wellauer; Research Engineer, The Falk Corp., 3001 W. Canal St., Milwaukee, Wis.

Producers

E. J. Edwards; Chief Metallurgical Engineer, American Locomotive Co., N. Jay St., Schenectady, N. Y.
William Finkl; Vice-President, A. Finkl and Sons Co., 2011 Southport Ave., Chicago, Ill.
J. H. Higgins; Materials Engineer, Camden Forge Co., Camden, N. J.
C. W. Johnson; Metallurgist, National Forge and Ordnance Co., Irvine, Pa.
S. D. Johnson; Works Manager, Titusville Forge Co., Titusville, Pa.
J. R. McGlone; Superintendent, Erie Forge Co., Erie, Pa.
C. I. Niedringhaus; Chief Metallurgical Engineer, Mesta Machine Co., Pittsburgh, Pa.
Lewis Probst; Pennsylvania Forge Co., Tacony, Philadelphia, Pa.
A. O. Schaefer; Engineer of Tests, The Midvale Co., Nicetown, Philadelphia, Pa.
A. P. Spooner; Metallurgical Engineer, Bethlehem Steel Co., Bethlehem, Pa.
R. W. Steigerwalt; Metallurgical Engineer, Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
J. A. Succop; Chief of Research, Heppenstall Co., Pittsburgh, Pa.
J. D. Tyson; Chief Metallurgist, Standard Steel Works Div., Baldwin Locomotive Works, Burnham, Pa.

Consultants

H. C. Chamberlain; British Raw Materials Mission, 1801 K St., N. W., Washington, D. C.
J. C. Morrow; Chief Metallurgist, Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada
F. H. Saniter; British Raw Materials Mission, 1801 K St., N. W., Washington, D. C.

Sections of TAC 16

Section I on Gears, Pinions, and Rings

Chairman: A. O. Schaefer, Engineer of Tests and Inspection, The Midvale Co.
Co-Chairman: F. H. Pennell, Chief Metallurgist, DeLaval Steam Turbine Co.

Section II on Ship Shafts, Hull and Engine Forgings

Chairman: J. H. G. McConechy, Chief Engineer, Sun Shipbuilding and Dry Dock Co.
Co-Chairman: J. H. Higgins, Materials Engineer, Camden Forge Co.

Section III on Turbine and Generator Forgings

Chairman: C. J. Boyle, Works Laboratory, General Electric Co.

Section IV on Petroleum and Chemical Industry Forgings

Chairman: A. P. Spooner, Metallurgical Engineer, Bethlehem Steel Co., Inc.

Section V on General Purpose Forgings

Chairman: N. L. Mochel, Manager, Metallurgical Engineering, Westinghouse Electric and Manufacturing Co.

Section VI on Blooms and Ingots for Reforging

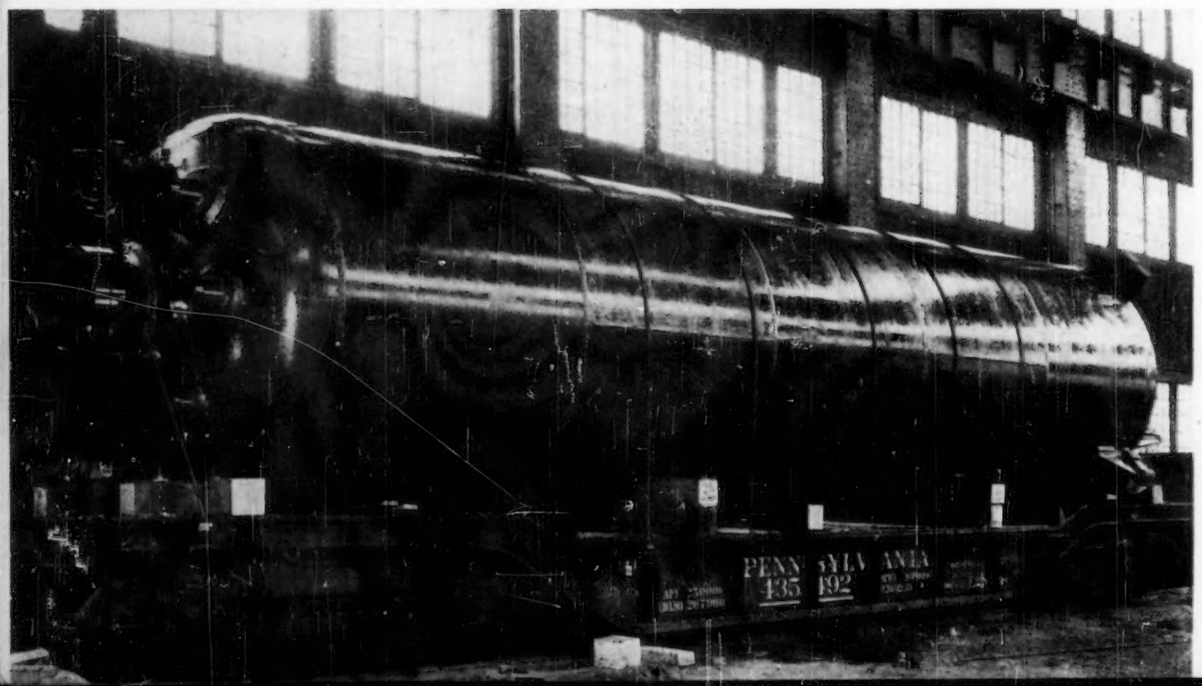
Chairman: R. W. Steigerwalt, Metallurgical Engineer, Railroad Materials and Forgings, Carnegie-Illinois Steel Corp.

Another Use of A.S.T.M. Standards

THE ACCOMPANYING illustration shows a high-pressure oil coking drum made from high tensile steel in accordance with A.S.T.M. Specifications A 212 (carbon-silicon steel plates for boiler and other pressure vessels), the ultimate tensile strength being 70,000 psi. The unit is for operation at 900 F. and 350 psi. pressure.

This illustration and others were part of a paper published by the magazine *Steel* as prepared by A. Grodner, Process Equipment Dept., Blaw-Knox Co., discussing available steels for the petroleum industry under present emergency conditions. An interesting part of the paper was a chart showing allowable working stresses for three principal grades of steel at elevated temperature with stresses according to the A.P.I.-A.S.M.E. code. The three types of steel include those covered by the specifications for carbon-steel plates for stationary boilers (A 70), carbon-silicon plates (A 212), and molybdenum steel plates (A 204). The allowable stress at 950 F. for both A 70 (firebox) and A 212, Grade B (70,000 to 82,000 psi. tensile) was about 5000 psi., then ranging upwards to a value of about 19,000 psi. for the Grade C (75,000 to 87,000 psi. tensile), A 204, at a temperature range from −20 to 750 F.

Cut courtesy of *Steel*



Supplementary NE Steels

9400, 9500, and 9600 Series

IN FURTHER EFFORTS to expedite procurement and conserve critical materials, the Committee on Alloy Steel of the American Iron and Steel Institute, at the request of the War Production Board, has developed a series of steels to be used as alternates for standard constructional alloy steels, and to supplant as far as possible previously publicized NE steels, including those in the 8000 series. While full details of these new 9400, 9500, and 9600 series steels are given in a publication entitled "Contributions to the Metallurgy of Steel, No. 8" (copies are available from the A.I.S.I., 350 Fifth Ave., New York, N. Y.), the chemical compositions of the steels are published here as Table I for the information of A.S.T.M. members. In the A.I.S.I. publication are the results of numerous hardenability tests, with charts showing relation between tensile strength, Brinell hardness, yield point, etc.

TABLE I.

The following steel compositions comprise both the NE steels and certain other recognized steel compositions which do not require the use of excessive quantities of strategic alloying elements.

CARBON-MANGANESE STEELS

	C	Mn	Si
NE 1330	0.28–0.33	1.60–1.90	0.20–0.35
NE 1335	0.33–0.38	1.60–1.90	0.20–0.35
NE 1340	0.38–0.43	1.60–1.90	0.20–0.35
NE 1345	0.43–0.48	1.60–1.90	0.20–0.35
NE 1350	0.48–0.53	1.60–1.90	0.20–0.35

MANGANESE-MOLYBDENUM STEELS

	C	Mn	Si	Mo
NE 8020	0.18–0.23	1.00–1.30	0.20–0.35	0.10–0.20
NE 8022	0.20–0.25	1.00–1.30	0.20–0.35	0.10–0.20
NE 8339	0.35–0.42	1.30–1.60	0.20–0.35	0.20–0.30
NE 8442	0.40–0.45	1.30–1.60	0.20–0.35	0.30–0.40

SILICON-MANGANESE AND SILICON-MANGANESE-CHROMIUM STEELS

	C	Mn	Si	Cr
NE 9255	0.50–0.60	0.70–0.95	1.80–2.20	.....
NE 9260	0.55–0.65	0.75–1.00	1.80–2.20	.....
NE 9262	0.55–0.65	0.75–1.00	1.80–2.20	0.20–0.40

MANGANESE-SILICON-CHROMIUM STEELS

	C	Mn	Si	Cr
NE 9630	0.28–0.33	1.20–1.50	0.40–0.60	0.40–0.60
NE 9635	0.33–0.38	1.20–1.50	0.40–0.60	0.40–0.60
NE 9637	0.35–0.40	1.20–1.50	0.40–0.60	0.40–0.60
NE 9640	0.38–0.43	1.20–1.50	0.40–0.60	0.40–0.60
NE 9642	0.40–0.45	1.30–1.60	0.40–0.60	0.40–0.60
NE 9645	0.43–0.48	1.30–1.60	0.40–0.60	0.40–0.60
NE 9650	0.48–0.53	1.30–1.60	0.40–0.60	0.40–0.60

CARBON-CHROMIUM STEELS

	C	Mn	Si	Cr	Ni	Mo
NE 52100A	0.95–1.10	0.25–0.45	0.20–0.35	0.40–0.60	0.35 Mx.	0.08 Mx.
NE 52100B	0.95–1.10	0.25–0.45	0.20–0.35	0.90–1.15	0.35 Mx.	0.08 Mx.
NE 52100C	0.95–1.10	0.25–0.45	0.20–0.35	1.30–1.60	0.35 Mx.	0.08 Mx.

NICKEL-CHROMIUM-MOLYBDENUM STEELS

	C	Mn	Si	Cr	Ni	Mo
NE 8613	0.12–0.17	0.70–0.90	0.20–0.35	0.40–0.60	0.40–0.60	0.15–0.25
NE 8615	0.13–0.18	0.70–0.90	0.20–0.35	0.40–0.60	0.40–0.60	0.15–0.25
NE 8617	0.15–0.20	0.70–0.90	0.20–0.35	0.40–0.60	0.40–0.60	0.15–0.25
NE 8620	0.18–0.23	0.70–0.90	0.20–0.35	0.40–0.60	0.40–0.60	0.15–0.25
NE 8630	0.28–0.33	0.70–0.90	0.20–0.35	0.40–0.60	0.40–0.60	0.15–0.25
NE 8715	0.13–0.18	0.70–0.90	0.20–0.35	0.40–0.60	0.40–0.60	0.20–0.30
NE 8720	0.18–0.23	0.70–0.90	0.20–0.35	0.40–0.60	0.40–0.60	0.20–0.30
NE 8722	0.20–0.25	0.70–0.90	0.20–0.35	0.40–0.60	0.40–0.60	0.20–0.30
NE 8735	0.33–0.38	0.75–1.00	0.20–0.35	0.40–0.60	0.40–0.60	0.20–0.30
NE 8739	0.35–0.40	0.75–1.00	0.20–0.35	0.40–0.60	0.40–0.60	0.20–0.30
NE 8740	0.38–0.43	0.75–1.00	0.20–0.35	0.40–0.60	0.40–0.60	0.20–0.30
NE 8744	0.40–0.45	0.75–1.00	0.20–0.35	0.40–0.60	0.40–0.60	0.20–0.30
NE 8749	0.45–0.50	0.75–1.00	0.20–0.35	0.40–0.60	0.40–0.60	0.20–0.30
NE 8949*	0.45–0.50	1.00–1.30	0.20–0.35	0.40–0.60	0.40–0.60	0.30–0.40

MANGANESE-SILICON-CHROMIUM-NICKEL-MOLYBDENUM STEELS

	C	Mn	Si	Cr	Ni	Mo
NE 9415	0.13–0.18	0.80–1.10	0.40–0.60	0.20–0.40	0.20–0.40	0.08–0.15
NE 9420	0.18–0.23	0.80–1.10	0.40–0.60	0.20–0.40	0.20–0.40	0.08–0.15
NE 9422	0.20–0.25	0.80–1.10	0.40–0.60	0.20–0.40	0.20–0.40	0.08–0.15
NE 9430	0.28–0.33	0.90–1.20	0.40–0.60	0.20–0.40	0.20–0.40	0.08–0.15
NE 9435	0.33–0.38	0.90–1.20	0.40–0.60	0.20–0.40	0.20–0.40	0.08–0.15
NE 9437	0.35–0.40	0.90–1.20	0.40–0.60	0.20–0.40	0.20–0.40	0.08–0.15
NE 9440	0.38–0.43	0.90–1.20	0.40–0.60	0.20–0.40	0.20–0.40	0.08–0.15
NE 9442	0.40–0.45	1.00–1.30	0.40–0.60	0.20–0.40	0.20–0.40	0.08–0.15
NE 9445	0.43–0.48	1.00–1.30	0.40–0.60	0.20–0.40	0.20–0.40	0.08–0.15
NE 9450	0.48–0.53	1.20–1.50	0.40–0.60	0.20–0.40	0.20–0.40	0.08–0.15
NE 9537*	0.35–0.40	1.20–1.50	0.40–0.60	0.40–0.60	0.40–0.60	0.15–0.25
NE 9540*	0.38–0.43	1.20–1.50	0.40–0.60	0.40–0.60	0.40–0.60	0.15–0.25
NE 9542*	0.40–0.45	1.20–1.50	0.40–0.60	0.40–0.60	0.40–0.60	0.15–0.25
NE 9550*	0.48–0.53	1.20–1.50	0.40–0.60	0.40–0.60	0.40–0.60	0.15–0.25

* Recommended for large sections only.

Also included here is a tabulation between standard steels and the NE steels—this table grouping the material according to the average hardenability values. For detailed information it is, of course, necessary to study the hardenability characteristics given in curves.

EMERGENCY STEEL EQUIVALENTS

Standard Steel	Recommended NE Steel
A 2317, A 2320, A 3115, A 3120, A 4023, A 4024, A 4119, A 4615, A 4620, A 5120, A 6120, NE 8620	8020 or 9420
A 4027, A 4032, A 4119, NE 8124	8022 or 9422
A 4320	8720, 9422
A 4815	8715, 9420
A 4820	8720, 9426
A 2512	8715, 9415
A 2515	8720, 9420
NE 8720	9420
NE 8817	8720, 9420
A 2330	NE 1330
A 3130	NE 1330
A 4037	NE 1330
A 4042	NE 1330
A 4047	NE 1335
A 4130	NE 1330
A 5130	NE 1330
A 6130	NE 1330
NE 8233	NE 1330
NE 8339	NE 1335
NE 8630	NE 1330
A 2335, A 3135, A 5135, A 5140, A 6135, A 6140, NE 8635, NE 8735	NE 1335 or 9635 or 9435
A 4137, A 4640, NE 8739	NE 1340 or 9637 or 9437
A 3045, A 3140, A 4140, A 4645, A 5145, A 6145	NE 1345 or 9640 or 9400
A 2340, A 3141, A 3240, A 4142, NE 8442, NE 8744	NE 1345 or 9642 or 9442
A *4337, A *4340, NE *8547	9537 or 9540
A 2345, A 3145, A 4145, A 5150, A 6150, A 8744, A 8749	NE 1350 or 9645 or 9445
A 2350, A 3150, A 3250, A 4150, NE *8949	9650 or 9450
A 4063, A 4065, A 4068	9255 or 9260 or 9262
E 52095, E 52098	52100C, 52100B
E 52099, E 52100, E 52101, E 52107	52100A

* Recommended for large sections only.

New AFA Light Alloys Division

ANNOUNCEMENT has been received from the American Foundrymen's Association of the pending organization of a Light Alloys Division. This is in recognition of the increased importance of aluminum and magnesium castings. The A.F.A. is dividing its present Non-Ferrous Division to create the new division, and members concerned with brass and bronze will be the nucleus for a Brass and Bronze Division. An Advisory Committee is being formed to direct the activities. Anyone interested in taking part is requested to contact R. E. Kennedy, Secretary of the A.F.A., 222 W. Adams St., Chicago, Ill.

Specifications for Stainless Electrodes

PUBLISHED IN THE August issue of the *Welding Journal* to elicit comments and criticism are proposed specifications for stainless steel arc-welding electrodes. These specifications now under the jurisdiction of the Joint A.W.S.-A.S.T.M. Committee on Filler Metal were developed by the former A.W.S. specification group. Before action in the Joint Committee, it was decided to issue them for comment. A.S.T.M. members and others who are concerned are urged to submit comments.

XXVIII. Long-Time Society Committee Members

Twenty-eighth in the Series of Notes on Long-Time Members

As a continuation of the series of articles in the ASTM BULLETIN comprising notes on the outstanding activities of long-time A.S.T.M. members, there are presented below outlines of the work of three additional members. In general, the men whose activities are described in this series have been affiliated with the Society for 25 years or more and have taken part in committee work for long periods of time. No definite sequence is being followed in these articles.

F. H. JACKSON, Senior Engineer of Tests, Public Roads Administration, attended Ohio State University for two years and George Washington University for one year, taking courses in chemical engineering He was appointed to the Office of Public Roads, U. S. Department of Agriculture, now the Public Roads Administration, in 1905 and has been with this organization up to the present time. He was appointed Assistant Engineer of Tests in 1915, Engineer of Tests in 1924 and Senior Engineer of Tests in 1928. He has been in charge of the Nonbituminous Road Materials Section since 1928.

F. H. Jackson H. F. Gonnerman J. J. Crowe

Mr. Jackson joined the Society in 1916 and has been active in the work of a number of its committees, including Committee C-1 on Cement (1921 to date), Committee C-9 on Concrete and Concrete Aggregates (1926 to date), Committee C-15 on Manufactured Masonry Units, and Committee D-4 on Road and Paving Materials. He was Secretary of Committee C-1 from 1926 to 1931 and is at present Chairman of Committee C-9, having served this very active committee in this capacity since 1938. He also served as a member of the Executive Committee from 1930 to 1932 and is at present a member of Committee E-10 on Standards.

Another of his important current activities in A.S.T.M. is as a member of the Editorial Committee preparing the 1942 Report on Significance of Tests on Concrete and Concrete Aggregates. He has prepared a revised and amplified version of the paper, "Mortar Strength Tests in Fine Aggregates," which appeared in the 1933 book.

In addition to the Society, Mr. Jackson is also affiliated with the American Concrete Institute, of which he is a former director, and the American Association of State Highway Officials. He has served as Secretary of the Committee on Materials of the latter organization for a number of years. He is also Chairman of the Technical Committee on Road and Paving Materials, Federal Specifications Executive Committee.

Mr. Jackson is the author of a number of papers and reports dealing with the properties of and the methods of testing portland cement concrete, concrete aggregates, and related materials, many of which appear in the A.S.T.M. *Proceedings*.

H. F. GONNERMAN, Manager, Research Laboratories, Portland Cement Association, Chicago, is a native of Illinois, and attended the University of Illinois, receiving his B.S. degree in Civil Engineering in 1908 and his Master's degree in 1913.

From 1908 to 1920 he was successively assistant instructor in theoretical and applied mechanics, first assistant, research associate, and research associate professor in the Engineering Experiment Station, at the University. During the summer of 1918 he was active in connection with concrete investigations of the U. S. Emergency Fleet Corp. Then followed a period of about two years in private business, and from 1922 to 1927 he was associate engineer in structural materials research laboratory, Lewis Institute, and Research Laboratory of P.C.A., and since 1927 has been in his present position.

Mr. Gonnerman has been very active in the work of the Society, his membership dating from 1914. He has been a member of Committee C-1 on Cement for over 15 years, and has served on many of the C-1 subcommittees, having been chairman of several of them. He is also currently a member of Committee D-4 on Road and Paving Materials, chairman of the subgroup on portland-cement concrete for pavements and bases. Formerly he served on Committee C-12 on Mortars for Unit Masonry, and was for a number of years affiliated with Committee E-1 on Methods of Testing. He was a member of the Society's Executive Committee from 1936 to 1938.

Mr. Gonnerman has contributed many notable technical papers to the literature on concrete, many of which have been published by the American Concrete Institute and by the A.S.T.M.

His other Society activities include the Western Society of Engineers and the American Society of Civil Engineers. Mr. Gonnerman resides in Oak Park, Ill.

JOHN J. CROWE, Assistant Vice-President, Air Reduction Co., Inc., Jersey City, was born in the District of Columbia. His technical education was obtained at George Washington University, and following this he was from 1905 to 1915 on the staff of the National Bureau of Standards. From then until 1924 he was Physical Metallurgist, U. S. Navy, during which period from 1921 to 1924 he served as Director of the course in Metallurgy at Temple University. (At the joint A.S.M.-A.S.T.M. meeting on October 2 at Temple University which initiated the twenty-first year of the A.S.M.-Temple course, reference was made to Mr. Crowe's work in helping to establish this very successful cooperative venture.) From 1924 to the present time he has been with the Air Reduction

Co., Inc., concerned particularly with apparatus research and development.

He has been a member of A.S.T.M. since 1913, and has served for many years on several of the Society's committees, particularly in the metals field, including Committees A-9 on Ferro-Alloys, B-2 on Non-Ferrous Metals and Alloys (each since 1924), B-5 on Copper and Copper Alloys, Cast and Wrought, and A-1 on Steel, where his work concerned chiefly the subcommittee on welding (later covering filler metal). He is continuing his interest in this work as a member of the new joint A.W.S.-A.S.T.M Committee on Filler Metal. Mr. Crowe is a past-chairman of the Philadelphia and New York Chapters of the A.S.M., Past-President of the A.W.S., and also of the Compressed Gas Mfrs. Association. He holds membership in the International Acetylene Association. In 1938 he was awarded the Morehead Medal for outstanding work with acetylene. Mr. Crowe resides in Westfield, N. J.

Emergency Standard for Design and Erection of Structural Steel

NATIONAL EMERGENCY specifications for the design, fabrication, and erection of structural steel for buildings were established on September 10, 1942, by the War Production Board, through WPB Directive No. 8, in which it is ordered that a manual of specifications apply to and govern the use of structural steel for all buildings which are constructed, financed, or approved by governmental agencies on contracts placed after November 9, 1942. The manual was developed under the direction of the Specifications Branch of the WPB Conservation Division.

The purpose of the directive is to conserve the supply of structural steel by requiring the use of higher design unit stresses than are normally used in the design of structural steel for buildings. By using these stresses, somewhat lighter sections of beams and other members entering into the construction of buildings will be permitted, but not to an extent that in any way endangers the safety of the building.

The most important provision of the specifications is contained in Section 10 which lists allowable design unit stresses. These unit stresses are higher for tension and bending than those now in use. For example, the allowable unit stress in tension is 24,000 psi., which compares with values presently in use ranging from as low as 16,000 up to 20,000 psi. Section 10 expresses the stresses as maximum allowable stresses, and, for the purpose of attaining maximum conservation of steel, requires that lower stresses than those specified shall not be used in the design of the building. Furthermore, since steel will be conserved by using the principle of continuity in structural design and by using welded fabrication, it is desired that, wherever possible, buildings be designed in accordance with these principles; hence, the designer is required in the directive to certify that the building has been designed to secure the greatest savings of steel practicable through continuity of design and through welded fabrication. Where such is not possible or practicable, and where other exceptions to the provisions of the directive may be necessary, authority for such exceptions is provided in paragraph (*f*) of the directive.

It is estimated that the use of these specifications will result in a saving of approximately 10 per cent of the weight of structural steel entering into building construction. The tonnage saved, of course, depends on the amount of future construction. Some quantitative measure of the saving is indicated by the statistics for 1941 which show that approximately 2 million tons of structural steel were used that year.

The specifications manual is binding upon WPB, the Army, Navy, Maritime Commission, Reconstruction Finance Corp., National Housing Agency, and all other Government departments and agencies in respect to war construction and the financing of war construction.

Broadly speaking the manual follows the policy stated in the joint directive of Wartime Construction made by WPB and the War and Navy Departments on May 20, 1942 (WPB-1249) and the "List of Prohibited Items for Construction Work" issued by the Army and Navy Munitions Board on April 1 and revised on June 29, 1942.

Although the effective date is November 9, the agencies were empowered to put the directive into immediate effect wherever possible. Where contracts already have been placed or will be placed before the November 9 deadline, Mr. Nelson directed that they should be reviewed by the sponsoring agencies promptly and changes made in accordance with the emergency specifications unless such changes will result in a substantial delay in the war effort.

Agencies undertaking or approving wartime construction are directed to obtain from the person in charge of the design of each building a certificate to the effect that the emergency specifications have been complied with and that the building has been designed to secure the greatest savings of steel practicable through continuity in design and through welded fabrication. In cases where Form PD-200 must be filed with WPB in order to obtain authorization to begin construction the certificate should be filed with the form.

Authority to depart from the provisions of the directive may be granted, upon specific request, by WPB.

The developments leading to the measures of conservation required by this directive have been initiated and guided by the Specifications Branch, Conservation Division. The National Emergency Specifications attached to the directive are based upon long standing and authoritative specifications of the American Institute of Steel Construction, modified in respect primarily to allowable unit stresses to effect the desired measure of conservation. They were reviewed in detail by a group of engineers and designers selected from the Governmental agencies most directly concerned with this subject and brought together by the Specifications Branch under the chairmanship of H. L. Whittemore, Chief of the Engineering Mechanics Section, National Bureau of Standards, who serves also as Consultant to the Branch.

The specifications part of the WPB directive has been published by the American Institute of Steel Construction, Inc., 101 Park Avenue, New York, N. Y. Copies can be obtained through their district offices or by writing directly. A charge of 25 cents per copy is being made.

Amendment in Cement Order L-179

An amendment has been issued to the general limitation order L-179 which sets up certain restrictions on the manufacture, storage, and testing of portland cement. This amendment dated September 24, signed by Ernest Kanzler, Director General for Operations, is summarized below. A new Section 2 reads as follows:

(2) *Storage of cement by manufacturers.* On and after September 24, 1942, no manufacturer of portland cement shall set aside, or continue to set aside, except during the testing period of such cement, any storage space for the storage of portland cement for the exclusive use of any one or more departments, agencies or governmental corporations of the United States or for the exclusive use of any one or more persons; but such manufacturer may set aside storage space for portland cement tested in accordance with the provisions of this order for the use in common by all departments, agencies and governmental corporations of the United States, or for the use in common of all other purchasers of such tested cement.

Section 3 covers requirements for testing. This section has been changed from the original order to read as follows:

(3) *Requirements for testing.* A purchaser of portland cement may require tests of such cement, but such tests may only be made in accordance with "Federal Specifications: Emergency Alternate Federal Specifications for Cement; Portland—Dated June 5, 1942, E-SS-C158a" or "American Society for Testing Materials Specifications C 77–40." Such tests shall be made only by a laboratory selected by the manufacturer of such cement, which laboratory, however, shall be either the National Bureau of Standards or a laboratory designated by the National Bureau of Standards.

An important addition in this section is the reference that the laboratory be selected by the manufacturer, which laboratory shall be either the National Bureau of Standards or a laboratory designated by the Bureau.

This general limitation order L-179 incorporates references to several Federal and A.S.T.M. specifications as EA C 150, Types I, II, and III, and it will be noted that in the Section on Requirements for Testing A.S.T.M. Standard C 77 – 40 is embodied.

In much of the preliminary work leading up to the limitation order, a special group of Committee C-1 on Cement closely cooperated, this group being headed by J. L. Miner, Vice-President, The Atlas Lumnite Cement Co.

OPA Organizes Standards Division

Announcement has been made of the organization of a Standards Division operating as a full division in the Office of Price Administration. This new division is to cooperate closely with other OPA units giving technical assistance in developing standards. The Standards Division has also been given authority to deal with labeling of goods in accordance with the standards, and has been given supervision over all testing to determine compliance with and enforcement of the standards.

Dexter M. Keezer, Deputy Administrator in charge of general services, will act as director of the Standards Division, and W. S. MacLeod, as chief of technical operations. Mr. MacLeod was formerly with the Standard Oil Company of New Jersey. Dickson Reck will be Mr. MacLeod's senior technical associate. Mr. Reck has been with OPA and its predecessors for two years. He formerly was assistant to the general manager of the Square D Company, Detroit, and later a lecturer at the Wharton School of the University of Pennsylvania.

In his statement accompanying the announcement of the new division, Leon Henderson, Price Administrator, referred to the scarcity of many materials and the use of substitutes, which situation creates problems for the ordinary civilian and for commercial buyers.

He pointed out that the Emergency Price Control Act of 1942 in addition to vesting in OPA the authority to set maximum prices, gave it power to regulate and prohibit practices relating to form and quality.

A recent announcement in the magazine *Victory*, October 6 issue, covers the formation of a 12-member interdepartmental advisory committee. Mr. Keezer, who made the announcement, said that the committee, of which Dr. Faith Williams, Chief of the Cost-of-Living Division of the Department of Labor, is chairman, was created to assist the standards division by—

Helping it to avoid duplicating work already being done in the standards field by other agencies; helping it to assign new projects to the agency which can best carry out such work; giving technical advice on specific problems confronting the division, both in the field of standards and the field of operations; helping it to determine the best priorities to govern its work; giving it the benefit of its criticism and support; calling the attention of the standards division to new projects which the division might well undertake.

Serving with Doctor Williams will be:

John Cassels, Chief of Requirements and Allocations Branch, Office of Agricultural War Relations;
Howard Coonley, Chief of Simplification Branch, Conservation Division, WPB;
Clarence W. Kitchen, Agricultural Marketing Administration, Department of Agriculture;
Addams S. McAllister, Chief, Division of Codes and Specifications, National Bureau of Standards;
Henry Miller, Federal Trade Commission;
Donald E. Montgomery, Consumers' Council, Agricultural Marketing Administration;
Ruth O'Brien, Bureau of Home Economics, Textile Division Research Center, Beltsville, Md.;
W. B. White, Chief of Food Division, Department of Agriculture;
H. J. Wollner, Chief, Division of Laboratories, Bureau of Customs, Treasury Department;
Walter G. Campbell, Food and Drug Division, Department of Agriculture;
C. W. Crawford, Principal Technical Advisor, Food and Drug Administration.

American Standards Association Contract

In connection with the formation of the OPA Standards Division, it is of interest to note a contract entered into by the Federal government with the American Standards Association in the development of emergency or war standards for WPB and OPA.

Under it the A.S.A. is "to provide services in creating standards which include one or more of the following items, and any other assignments or projects which may be requested by the Government which come within the scope of the Association.

(*a*) Nomenclature
(*b*) Uniformity in dimensions to provide for inter-

changeability of parts and supplies or the interworking of apparatus

(c) Specifications for materials and products
(d) Methods of test or inspection
(e) Methods of rating machinery or apparatus
(f) Safety standards
(g) Rules for the operation of apparatus or machinery
(h) Concentration upon the optimum number of types, sizes, grades, and colors."

The Simplification and Radio branches of the WPB and the Standards Division of OPA will supervise the work for the Government.

Under the contract the Association will be reimbursed by the Government for the actual cost of the work undertaken specifically for WPB and OPA.

The contract is limited to $90,000 in any one fiscal year. Of this sum $60,000 is to be supplied by the War Production Board and $30,000 by the Office of Price Administration.

The A.S.T.M. is, of course, definitely concerned with the phase of this work which concerns specifications for materials and products, methods of testing and inspection and it is understood that full cognizance will be taken by the A.S.A. of A.S.T.M. work and facilities. Contacts have been made with the Chief of Technical Operations of the OPA.

New API Viscosity Standards

The American Petroleum Institute Committee on Viscosity Standards has prepared a new Alpha oil and recalibrated the Beta and Gamma oils, thus giving a new series of oils. The official viscosities for these three oils are as follows:

	Alpha 41	Beta 41	Gamma 41
Kinematic Viscosity			
Centistokes at 100 F.	62.33	384.0	3.033
" " 122 F.	....	182.9	....
" " 210 F.	7.57	23.91	....
Saybolt Universal (by conversion)			
Seconds at 100 F.	288.1	1774	36.1
" " 210 F.	50.9	115.0	....
Saybolt Furol (by conversion)			
Seconds at 122 F.	....	86.7	....

The oil standards are available at the following prices:

1 quart	$5.00
1/2 pint	2.50

Orders for samples should be sent to Dr. T. G. Delbridge, Chairman, 3144 Passyunk Ave., Philadelphia, Pa., with check drawn exactly that way.

Notes on Specifications Branch—WPB Conservation Division

The Specifications Branch of the WPB Conservation Division has numerous projects completed or under way which are of interest to A.S.T.M. members—in fact, many members are participating in some of the activities. A.S.T.M. Secretary-Treasurer C. L. Warwick continues to devote most of his time to his duties as Chief of this Branch which with the other three Branches (Substitution, Harvey Anderson; Simplification, R. B. Shepard; and Salvage, Paul Cabot) comprise the WPB Conservation Division headed by Lessing J. Rosenwald. Including technical men, secretaries, etc., the division personnel in Washington now numbers about 435. There are also several offices in industrial centers—New York, Chicago, etc. Main offices are in the Washington Gas Light Building, 11th and H Sts.

Many members will be interested in a very recent announcement of the appointment of Howard Coonley as Deputy Director of the Conservation Division, serving in this capacity with Mr. Cabot. Succeeding Mr. Coonley as head of the Simplification Branch is R. B. Shepard, formerly of the Underwriters' Laboratories, Inc., New York.

The following notes outline some of the principal activities of the Specifications Branch.

Some of the Principal Activities of the Specifications Branch, Conservation Division, WPB

1. *Federal Specifications.*—Collaboration with Federal Specification Committees in the preparation of some 450 Emergency Alternate Federal Specifications for use by all Government agencies, including the armed services wherever the alternate provisions are suited.

The Chief of the Branch is officially a member of the 71 Federal Specification Committees, with Alternates named from the staff. Through this arrangement the Branch can propose revisions in Federal Specifications necessitated by the material situation and participates in the discussions and decisions of the Federal Committee; also the tie-in permits a correlation of provisions of L and M orders as they are issued with revision of specifications.

Many Federal Specifications have been revised (as distinguished from issuance of Federal emergency alternate specifications). This procedure is particularly useful in adding to existing specifications new grades of materials with wider composition limits to permit a greater use of scrap.

2. *Procurement Division Specifications.*—All Procurement Division Specifications, some 350 in number, have been reviewed with the following broad results: Many recommended for suspension during the emergency, except for purchases of absolute military necessity; many more revised or superseded by a Federal specification; balance found to require no modification or still under consideration.

3. *Army and Navy Specifications.*—Many of these specifications have been revised upon recommendation of the Specifications Branch. Some of this work is closely related to Federal specification activities, but much of it deals with materials and products covered only by armed service specifications. There are still many opportunities for further accomplishments in this field, especially as the materials situation grows tighter. Recent establishment of liaison relations with Army S.O.S. and Navy Procurement will facilitate this work.

4. *Maritime Commission.*—Within the past three months extensive changes in specifications for cargo and other Maritime vessels have been made, so that vessels will contain much less critical material—especially copper, brass and bronze, and rubber. Much saving has been effected by widening impurity limits in specifications to permit greater use of scrap in production. Extensive substitution of ferrous for non-ferrous metal parts is now being made.

5. *National Emergency Steel Specifications.*—Project sponsored by A.S.T.M., A.I.S.I., and S.A.E. to establish lists of minimum number of steel specifications, compositions, sizes and shapes for wide variety of steel products, *e.g.*, plates, shapes, concrete reinforcement bars, rails and track accessories, wheels and tires, railroad axles and forgings, pipe and tubing, heavy forgings, aeronautical and automotive steels, bars and billets. Limitation Order limiting production and procurement to such specifications is now in process of issuance. Lists include selected Govern-

ment and industrial specifications, eliminating for the duration countless private specifications.

6. *Industry Specifications.*—The Branch has stimulated important revisions in widely used industry specifications, especially those of the American Society for Testing Materials. This organization has issued nearly 100 emergency amendments (pink slips) and some 20 complete new emergency standards. Splendid cooperation in conservation activities has been obtained from the national technical and trade associations.

7. *Conservation Through Design.*—Much conservation can be effected through use of higher design stresses in various types of structures. Some accomplishments to date are:

(*a*) National Emergency Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings, made effective September 10, 1942, through Directive No. 8 of Mr. Nelson (see separate article in this BULLETIN).

(*b*) National Emergency Specifications for the Design of Reinforced Concrete Buildings, made effective October 5, 1942, through Directive No. 9 of Mr. Nelson; recommends use of unreinforced concrete when possible and requires use of larger concrete members and less reinforcement steel through increased design stresses in steel.

(*c*) Boilers and other pressure vessels. The American Society of Mechanical Engineers has recently issued rulings permitting, under stipulated conditions, increases of allowable design stresses of 25 per cent in their Boiler Code for Design of Boilers and Similar Structures.

(*d*) Work is being initiated toward similar savings in the design of steel and concrete bridges and other structures.

8. *Restrictions in Use of Critical Materials in Construction.*—

(*a*) The Branch has established a list of "Critical Construction Materials" as a guide to all agencies concerned with review and "stripping" of construction projects. This is brought up to date periodically and its use is guided and controlled by staff members assigned to the Bureau of Construction and the Bureau of Governmental Requirements, who review all but a few highly special projects.

(*b*) Cooperated continuously in the preparation of the Army and Navy Munitions Board List of Prohibited Items for Construction Work, which is now, by virtue of WPB Directive for War-Time Construction, mandatory for a wide variety of construction.

(*c*) The Defense Housing Critical List prepared originally in the Specifications Branch. Its successor, the War Housing Critical List, developed with its cooperation. Closely tied in with (*a*) and (*b*).

(*d*) Collaborated in the preparation of Emergency Plumbing Standards for Defense Housing, and Builders' Hardware Manual.

(*e*) Prepared List of Critical Materials for Construction of Highways, Bridges and Culverts, promulgated March, 1942, by Public Roads Administration. Revised edition completed and released Oct. 5, 1942.

(*f*) As a guide in review and re-design of buildings, a study of typical mill buildings of several spans and some 25 types of roof decking just completed showing comparative weights of steel per square foot of floor area for each type of design.

9. *Chemicals.*—Some significant projects are: revision of specifications for rubber and rubber goods, including tires and tubes; paint, varnish and lacquer specifications revised to conserve pigments, and drying oils; soap specifications revised to conserve glycerin. Membership on committee to advise Combined Raw Materials Board on purchase and use of shellac. Also work on insecticides, degreasing solvents, gasoline, food products. Review of orders covering all chemicals important phase of this work.

10. *Electrical and Mechanical and Miscellaneous.*—Some significant projects are: Specifications for electrical equipment of all kinds, especially wire and cable to conserve copper, tin and rubber; review of Maritime practices in ship wiring; variety of electric appliances used by armed services; specifications for mechanical equipment such as boilers, heaters, gasoline engines, refrigeration equipment, manufacturing machinery. Miscellaneous subjects include rope (manila, hemp, sisal and other fibers), textiles, paper, brushes, containers.

11. *Metals.*—Some significant projects in this field are: fire-fighting equipment, including OCD stirrup pumps; mess trays and similar eqipment for armed services; specification changes to permit extensive use of scrap in place of virgin metal; substitution of lower grade for higher grade metals, and of ferrous for non-ferrous metals.

(*Editor's Note.*—Space limitations prevent details of many of the above items. Significant phases involve use of hair felt for foam rubber; pyrethrum and rotenone; bomb safety clips; shellac; hemp growing; bristtes, brushes and brooms; packaging gas masks; chain link fence; manila fiber, etc.)

Many Standards in New Canadian Building Code

AFTER WORK OF about four years' duration a national building code for Canada has been issued under the joint sponsorship of the National Housing Administration Department of Finance, and the Codes and Specifications Section of the National Research Council of Canada. Cooperating in the work were large numbers of technologists and other Government boards and professional and trade associations. A large number of A.S.T.M. specifications and tests are referred to in this code as indicated by the list of serial designations given below.

The code is in five parts dealing with administrative requirements, definitions, structural requirements, regulations on protection against loss of life and property from fire, and finally regulations bearing on health and sanitation. There are eleven helpful appendices. In the interest of compactness those responsible for the code have arranged it so that all regulations dealing with a particular subject are under one heading. For example, all regulations on exits are in this chapter. To make the code more helpful a very detailed subject index has been included.

In addition to many Canadian Engineering Standards the following A.S.T.M. specifications and tests are referred to in the code:

A 53 – 40	C 56 – 39	C 132 – 40 T
A 72 – 39	C 57 – 39	C 140 – 39
A 120 – 40	C 61 – 40	C 141 – 38 T
A 191 – 38	C 62 – 40 T	C 144 – 39 T
A 205 – 37 T	C 73 – 39	C 145 – 40
C 5 – 26	C 77 – 40	D 225 – 37 T
C 6 – 31	C 79 – 34	D 226 – 41 T
C 10 – 37	C 90 – 39	D 227 – 41
C 19 – 33	C 91 – 40	D 249 – 37 T
C 28 – 40	C 94 – 38	D 250 – 27
C 34 – 39	C 98 – 30 T	D 312 – 41
C 37 – 40	C 99 – 36	D 371 – 37 T
C 39 – 39	C 101 – 32 T	D 450 – 41
C 52 – 33	C 129 – 39	E 8 – 40 T
C 55 – 37	C 130 – 39	

It is of interest to note that this code makes provision in general terms for the introduction of new materials and methods of construction which procedure will be supplemented by the publication from time to time of revisions and additions.

Copies of the publication can be obtained at $1.00 each from the National Research Council of Canada, Ottawa, Ont., Canada.

EDITOR'S NOTE.—Comments and notes on some of these emergency alternate provisions appear in the news article beginning on page 8.

EA – A 21

Issued, October 5, 1942

The following Emergency Alternate Provision, when specified, may be used as an alternate in A.S.T.M. Standard Specifications for Carbon-Steel Axles for Cars and Tenders (A 21 – 36) and affects only the requirements referred to:

Section 3.—Change the present requirement for phosphorus from "0.05 max., per cent" to read as follows:

Phosphorus, max., per cent	basic steel	0.05
	acid steel	0.055

EA – A 25a

(Wrought Steel Wheels for Electric Railway Service) Details in December BULLETIN.

EA – A 83

Issued, August 18, 1942

The following Emergency Alternate Provision, when specified, may be used as alternates in A.S.T.M. Standard Specifications for Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes (A 83 – 42) and affects only the requirements referred to:

Section 17 (a).—Change this section on marking to read as follows by the addition of the italicized words and figures:

17. (*a*) The name or brand of the manufacturer, the type of material from which it is made, whether seamless or lap-welded, and whether steel or iron, *A.S.T.M. Specifications A 83*, together with the hydrostatic test pressure in pounds per square inch, shall be legibly stamped on each tube $1^1/_4$ in. in outside diameter and over, provided the length is not under 3 ft.

EA – A 120

Issued, August 24, 1942

The following Emergency Alternate Provisions, when specified, may be used as alternates in A.S.T.M. Standard Specifications for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses (A 120 – 42) and affect only the requirements referred to:

Section 1.—Designate this section as Paragraph (*a*) and add a new Paragraph (*b*) to read as follows:

(*b*) When used for water works service, pipe furnished shall be standard weight, unless otherwise specified.

Section 14.—Add a new Paragraph (*c*) to read as follows:

(*c*) *Water Works Service.*—In cases where the water or ground, or both, have been known to be corrosive, due consideration should be given to the protection of steel water pipe. It is recommended that if coatings are used they conform to the Standard Specifications for Coal-Tar Enamel Protective Coatings for Steel Water Pipe (A.W.W.A. No. 7A.6) of the American Water Works Association.

EA – A 134

Issued, August 18, 1942

The following Emergency Alternate Provisions, when specified, may be used as alternates in A.S.T.M. Standard Specifications for Electric-Fusion-Welded Steel Pipe (Sizes 30 in. and over) (A 134 – 42) and affect only the requirements referred to:

Section 2.—Change to read as follows:

2. When pipe made in accordance with these specifications is to be used for water works service, the steel plate to be selected by the manufacturer shall conform to one of the following specifications of the American Society for Testing Materials,[1] except that all references to manganese limitations shall be omitted: Standard Specifications for Steel for Bridges and Buildings (A.S.T.M. Designation: A 7); Standard Specifications for Mild Steel Plates (A.S.T.M. Designation: A 10) or for Low Tensile Strength Carbon-Steel Plates of Structural Quality for Welding (A.S.T.M. Designation: A 78), grade B.

Section 13.—Designate this section as Paragraph (*a*) and add a new Paragraph (*b*) to read as follows:

(*b*) *Water Works Service.*—Pipe thicknesses should be selected, not only with respect to the stresses to which the pipe will be subjected, but also with respect to the degree of corrosiveness of the soil and of the water to be carried, with due regard to the probable required life of the pipe and the cost of replacement. In cases where the water or ground, or both, have been known to be corrosive, due consideration should be given to the protection of steel water pipe, particularly that with thin walls. It is recommended that if coatings are used they conform to the Standard Specifications for Coal-Tar Enamel Protective Coatings for Steel Water Pipe of Sizes 30 in. and Over (A.W.W.A. No.: 7A.5–1940) of the American Water Works Association.

EA – A 135

Issued, August 24, 1942

The following Emergency Alternate Provision, when specified, may be used as an alternate in A.S.T.M. Standard Specifications for Electric-Resistance-Welded Steel Pipe (A 135 – 42) and affects only the requirements referred to:

Section 17.—Designate this section as Paragraph (*a*) and add a new Paragraph (*b*) to read as follows:

(*b*) *Water Works Service.*—Pipe thicknesses should be selected, not only with respect to the stresses to which the pipe will be subjected, but also with respect to the degree of corrosiveness of the soil and of the water to be carried, with due regard to the probable required life of the pipe and the cost of replacement. In cases where the water or ground, or both, have been known to be corrosive, due consideration should be given to the protection of steel water pipe, particularly that with thin walls. It is recommended that if coatings are used they conform to the Standard Specifications for Coal-Tar Enamel Protective Coatings for Steel Water Pipe of Sizes 30 in. and Over (A.W.W.A. No.: 7A.5–1940) and for Coal-Tar Enamel Protective Coatings for Steel Water Pipe of Sizes of $4^1/_2$ in. Outside Diameter up to but not Including 30 in. (A.W.W.A. No.: 7A.6–1940) of the American Water Works Association.

EA – A 139

Issued, August 18, 1942

The following Emergency Alternate Provisions, when specified, may be used as alternates in A.S.T.M. Standard Specifications for Electric-Fusion-Welded Steel Pipe (Sizes 8 in. to but not including 30 in.) (A 139 – 42) and affect only the requirements referred to:

Section 14.—Add the words "Except as specified in Paragraph (*c*)" at the beginning of the second sentence of Paragraph (*b*).

Add the following as a new Paragraph (*c*), relettering the present Paragraph (*c*) as (*d*):

(*c*) *Ends, Threaded Pipe for Oil Field Casing or Conductor Pipe.*—When threaded pipe is to be used for oil field casing or conductor pipe, all threads shall be in accordance with the requirements for casing threads in the Specifications for Steel and Iron Pipe for Oil Country Tubular Goods (A.P.I. No.: 5-A) of the American Petroleum Institute.

Section 17.—Designate this section as Paragraph (*a*) and add a new Paragraph (*b*) to read as follows:

(*b*) *Water Works Service.*—Pipe thickness should be selected, not only with respect to the stresses to which the pipe will be subjected, but also with respect to the degree of corrosiveness of the soil and of the water to be carried, with due regard to the probable required life of the pipe and the cost of replacement. In cases where the water or ground, or both, have been known to be corrosive, due consideration should be given to the protection of steel water pipe, particularly that with thin walls. It is recommended that if coatings are used they conform to the Standard Specifications for Coal-Tar Enamel Protective Coatings for Steel Water Pipe of Sizes of $4^1/_2$ in. Outside Diameter up to but not Including 30 in. (A.W.W.A. No.: 7A.6–1940) of the American Water Works Association.

EA – A 161

Issued, August 18, 1942

The following Emergency Alternate Provisions, when specified, may be used as alternates in A.S.T.M. Standard Specifications for Seamless Low-Carbon and Carbon-Molybdenum Steel Still Tubes for Refinery Service (A 161 – 40) and affect only the requirements referred to:

Section 4 (a).—In the table of chemical requirements, change the re-

quirements for sulfur, silicon, and molybdenum to read as follows:

	Low-Carbon Steel Tubes	Carbon-Molybdenum Steel Tubes
Sulfur, max., per cent	0.045	0.05
Silicon, per cent	0.10 min.	0.10 to 0.50
Molybdenum, per cent	.....	0.40 to 0.55

EA – A 178

Issued, August 18, 1942

The following Emergency Alternate Provision, when specified, may be used as an alternate in A.S.T.M. Standard Specifications for Electric-Resistance-Welded Steel and Open-Hearth-Iron Boiler Tubes (A 178 – 40) and affects only the requirements referred to:

Section 18 (a).—Change this section on marking to read as follows by the omission of the words in brackets, and the addition of the italicized words and figures:

18. (*a*) The name or brand of the manufacturer, the type of material from which it is made [the words Electric Resistance Welded] and whether steel or open-hearth iron, *A.S.T.M. Specifications A 178*, together with the hydrostatic test pressure in pounds per square inch, shall be legibly stenciled on each tube $1\frac{1}{4}$ in. in outside diameter and over, provided the length is not under 3 ft.

EA – A 179

Issued, August 18, 1942

The following Emergency Alternate Provision, when specified, may be used as an alternate in A.S.T.M. Standard Specifications for Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes (A 179 – 42) and affects only the requirements referred to:

Section 9.—Change to read as follows by the addition of the note:

9. Each tube shall be tested at the mill and shall withstand a hydrostatic pressure of 1000 psi.

NOTE.—When requested by the purchaser and so stated in the order, tubes shall be tested to one and one-half times the specified working pressure (when one and one-half times the specified working pressure exceeds 1000 psi.) provided the fiber stress corresponding to those test pressures does not exceed 16,000 psi., as determined by the following formula:

$$S = \frac{PD}{2t}$$

where:
P = hydrostatic test pressure in pounds per square inch,
D = outside diameter of the tube in inches, and
t = thickness of the tube wall in inches.

EA – A 192

Issued, August 18, 1942

The following Emergency Alternate Provision, when specified, may be used as an alternate in A.S.T.M. Standard Specifications for Seamless Steel Boiler Tubes for High-Pressure Service (A 192 – 40) and affects only the requirements referred to:

Section 4.—In the table of chemical composition requirements, change the requirement for silicon from "0.25 max. per cent" to read "0.10 min. per cent."

EA – A 199

Issued, August 18, 1942

The following Emergency Alternate Provisions, when specified, may be used as alternates in A.S.T.M. Standard Specifications for Seamless Cold-Drawn Intermediate Alloy-Steel Heat-Exchanger and Condenser Tubes (A 199 – 40) and affect only the requirements referred to:

Table I.—Change to read as follows by the omission of grades 2, 3, and 4: the revision of grades 1, 5, and 6, and the addition of grades E7, 8, and E9,

Section 9 (b).—Change to read as follows:

(*b*) Tubes of grades E7 and E9 compositions shall have a Rockwell hardness number not to exceed B89; all other tubes shall have a Rockwell hardness number not to exceed B85.

TABLE I.—CHEMICAL REQUIREMENTS.

	Grade 1	Grade 5	Grade 6	Grade E7	Grade 8	Grade E9
Carbon, max., per cent	0.15	0.15	0.15	0.15	0.15	0.15
Manganese, per cent	0.30 to 0.60	0.30 to 0.60	0.30 to 0.60	0.30 to 0.60	0.30 to 0.60	0.30 to 0.60
Phosphorus, max., per cent	0.04	0.04	0.04	0.04	0.04	0.04
Sulfur, max., per cent	0.04	0.04	0.04	0.04	0.04	0.04
Silicon, per cent	0.50 to 1.00	0.50 max.	0.50 max.	0.50 to 1.00	0.50 max.	0.50 to 1.00
Chromium, per cent	1.00 to 1.50	2.75 to 3.25	2.00 to 2.50	6.00 to 7.50	4.00 to 5.50	8.00 to 9.50
Molybdenum, per cent	0.40 to 0.55	0.80 to 0.95	0.80 to 0.95	0.40 to 0.55	0.40 to 0.55	0.80 to 0.95

EA – A 200

Issued, August 18, 1942

The following Emergency Alternate Provisions, when specified, may be used as alternates in A.S.T.M. Standard Specifications for Seamless Intermediate Alloy-Steel Still Tubes for Refinery Service (A 200 – 40) and affects only the requirements referred to:

Table I.—Change to read as follows by the omission of grades 2, 3, and 4, the revision of grades 1, 5, and 6, and the addition of grades E7, 8, and E9:

Section 9 (a).—Change to read as follows:

(*a*) Tubes of grades E7 and E9 compositions shall have a Brinell hardness number not to exceed 179; all other tubes shall have a Brinell hardness number not to exceed 163.

TABLE I.—CHEMICAL REQUIREMENTS.

	Grade 1	Grade 5	Grade 6	Grade E7	Grade 8	Grade E9
Carbon, max., per cent	0.15	0.15	0.15	0.15	0.15	0.15
Manganese, per cent	0.30 to 0.60	0.30 to 0.60	0.30 to 0.60	0.30 to 0.60	0.30 to 0.60	0.30 to 0.60
Phosphorus, max., per cent	0.04	0.04	0.04	0.04	0.04	0.04
Sulfur, max., per cent	0.04	0.04	0.04	0.04	0.04	0.04
Silicon, per cent	0.50 to 1.00	0.50 max.	0.50 max.	0.50 to 1.00	0.50 max.	0.50 to 1.00
Chromium, per cent	1.00 to 1.50	2.75 to 3.25	2.00 to 2.50	6.00 to 7.50	4.00 to 5.50	8.00 to 9.50
Molybdenum, per cent	0.40 to 0.55	0.80 to 0.95	0.80 to 0.95	0.40 to 0.55	0.40 to 0.55	0.80 to 0.95

EA – A 209

Issued, August 18, 1942

The following Emergency Alternate Provision, when specified, may be used as an alternate in A.S.T.M. Tentative Specifications for Seamless Carbon-Molybdenum Alloy-Steel Boiler and Superheater Tubes (A 209 – 42) and affects only the requirements referred to:

Table I.—Change the molybdenum requirement for grades T1, T1a, and T1b from "0.45 to 0.65" to read "0.40 to 0.55" per cent.

EA – A 211

Issued, August 18, 1942

The following Emergency Alternate Provisions, when specified, may be used as alternates in A.S.T.M. Standard Specifications for Spiral-Welded Steel or Iron Pipe (A 211 – 40) and affect only the requirements referred to:

Section 1.—Designate this section as Paragraph (*a*) and add a new Paragraph (*b*) to read as follows:

(*b*) When pipe made in accordance with these specifications is to be used for water works service, the size and wall thickness shall be in accordance with the following table unless heavier thicknesses are produced for other purposes, or if such are in stock which will conform to the requirements of these specifications:

Nominal Pipe Size, in.	Wall Thickness, in.	Nominal Pipe Size, in.	Wall Thickness, in.
4	0.105	10	0.135
	0.135	12	0.135
6	0.105	14	0.135
	0.135	16	0.135
8	0.105	18	0.135
	0.135	20	0.135

Section 2.—Add the following specifications to the list at the end of this section:

Tentative Specifications for Light Gage Structural Quality Flat Hot-Rolled Carbon Steel (0.2499 and 0.1874 in. to 0.0478 in. in Thickness) (A.S.T.M. Designation: A 245, grades A, B, or C.

Section 8.—Designate this section as Paragraph (*a*) and add a new Paragraph (*b*) to read as follows:

(*b*) *Water Works Service.*—Pipe thicknesses should be selected, not only with respect to the stresses to which the pipe will be subjected, but also with respect to the degree of corrosiveness of the soil and of the water to be carried, with due regard to the probable required life of the pipe and the cost of replacement. In cases where the water or ground, or both, have been known to be corrosive, due consideration should be given to the protection of steel water pipe, particularly that with thin walls. It is recommended that if coatings are used they conform to the Standard Specifications for Coal-Tar Enamel Protective Coatings for Steel Water Pipe of Sizes 30 in. and Over (A.W.W.A. No.: 7A.5–1940) and for Coal-Tar Enamel Protective Coatings for Steel Water Pipe of Sizes of 4½ in. Outside Diameter up to but not Including 30 in. (A.W.W.A. No.: 7A.6–1940) of the American Water Works Association.

EA – A 213

Issued, August 24, 1942

The following Emergency Alternate Provisons, when specified, may be used as alternates in A.S.T.M. Standard Specifications for Seamless Alloy-Steel Boiler and Superheater Tubes (A 213 – 42) and affect only the requirements referred to:

Table I.—Change this table of chemical requirements to read as follows by the omission of ferritic steel grades T3, T12, T13, T14, and T17, the revision of grades T5, T11, T16, T21, and T22, and the addition of grades TE7 and TE9:

TABLE I.—CHEMICAL REQUIREMENTS OF FERRITIC STEEL.

Identification Symbol	T5	T11	T16
Grade	Chromium-Molybdenum	Chromium-Silicon-Molybdenum	Chromium-Molybdenum-Titanium
Carbon, max., per cent	0.15	0.15	0.10 max.
Manganese, per cent	0.30 to 0.60	0.30 to 0.60	0.30 to 0.60
Phosphorus, max., per cent	0.04	0.04	0.04
Sulfur, max., per cent	0.04	0.04	0.04
Silicon, per cent	0.50 max.	0.50 to 1.00	0.50 max.
Chromium, per cent	4.00 to 5.50	1.00 to 1.50	4.00 to 5.50
Molybdenum, per cent	0.40 to 0.55	0.40 to 0.55	0.40 to 0.55
Titanium, per cent	....	....	0.35 to 0.60

Identification Symbol	T21	T22	TE7	TE9
Grade	Chromium-Molybdenum	Chromium-Molybdenum	7 per cent Chromium	9 per cent Chromium
Carbon, max., per cent	0.15 max.	0.15 max.	0.15	0.15
Manganese, per cent	0.30 to 0.60	0.30 to 0.60	0.30 to 0.60	0.30 to 0.60
Phosphorus, max., per cent	0.04	0.04	0.04	0.04
Sulfur, max., per cent	0.04	0.04	0.04	0.04
Silicon, per cent	0.50 max.	0.50 max.	0.50 to 1.00	0.50 to 1.00
Chromium, per cent	2.75 to 3.25	2.00 to 2.50	6.00 to 7.50	8.00 to 9.50
Molybdenum, per cent	0.80 to 0.95	0.80 to 0.95	0.40 to 0.55	0.80 to 0.95

Table II.—Change the requirements for austenitic steel grades T 18 and T 19 to read as follows:

	Grade T 18	Grade T 19
Carbon, max., per cent	0.10	0.10
Manganese, max., per cent	2.50	2.50
Phosphorus, max., per cent	0.04	0.04
Sulfur, max., per cent	0.04	0.04
Silicon, max., per cent	0.75	0.75
Nickel, min., per cent	9.00	9.50
Chromium, min., per cent	17.00	17.00
Titanium, per cent	*a*	....
Columbium, per cent	....	*b*

a Grade T 18 shall have a titanium content of not less than four times the carbon content and not more than 0.60 per cent.

b Grade T 19 shall have a columbium content of not less than eight times the carbon content and not more than 1.00 per cent.

Section 9 (c).—Change to read as follows:

(*c*) The tubes shall have a hardness number not to exceed the following:

Grade	Brinell Hardness Number	Rockwell Hardness Number
T5, T11, T16, T21, T22	163	B 85
TE7, TE9	179	B 89
T8, T18, T19, T20	190	B 90

EA – A 214

Issued, August 18, 1942

The following Emergency Alternate Provision, when specified, may be used as an alternate in A.S.T.M. Standard Specifications for Electric-Resistance-Welded Steel Heat-Exchanger and Condenser Tubes (A 214 – 42) and affects only the requirements referred to:

Section 9.—Change to read as follows by the addition of the note:

9. Each tube shall be tested at the mill and shall withstand a hydrostatic pressure of 1000 psi., for a minimum period of 10 sec. at the full pressure.

(*Over*)

NOTE.—When requested by the purchaser and so stated in the order, tubes shall be tested to one and one-half times the specified working pressure (when one and one-half times the specified working pressure exceeds 1000 psi.) provided the fiber stress corresponding to those test pressures does not exceed 16,000 psi., as determined by the following formula:

$$S = \frac{PD}{2t}$$

where:
P = hydrostatic test pressure in pounds per square inch,
D = outside diameter of the tube in inches, and
t = thickness of the tube wall in inches.

EA – A 226
Issued, August 18, 1942

The following Emergency Alternate Provisions, when specified, may be used as alternates in A.S.T.M. Standard Specifications for Electric-Resistance-Welded Steel Boiler and Superheater Tubes for High-Pressure Service (A 226 – 40) and affect only the requirements referred to:

Section 4.—In the table of chemical composition requirements, change the requirement for silicon from "0.25 max. per cent" to read "0.10 min. per cent."

Section 17 (a).—Change this section on marking to read as follows by the omission of the words in brackets:

17. (*a*) The name or brand of the manufacturer [the words Electric-Resistance-Welded Steel], *A.S.T.M. Specifications A 226*, together with the hydrostatic test pressure in pounds per square inch, shall be legibly stenciled on each tube $1\frac{1}{4}$ in. in outside diameter and over, provided the length is not under 3 ft.

EA – A 236
Issued, August 12, 1942

The following Emergency Alternate Provisions, when specified, may be used as alternates in A.S.T.M. Standard Specifications for Carbon-Steel Forgings for Locomotives and Cars (A 236 – 42) and affect only the requirements referred to:

Section 1 (b).—To the paragraph of this section which describes classes B, C, D, E, F, and G forgings add the following respecting classes H and I forgings:

H and I (quenched and tempered) for main and side rods, straps, crank pins, piston rods, and similar locomotive and car forgings.

Table I.—Make the following changes and additions in the requirements as to chemical composition:

Class A.....	Add a requirement for carbon content of 0.08 to 0.18 per cent
Classes A to G, inclusive.....	Change the requirement for phosphorus content from "0.05 or 0.045" to read "0.055" max., per cent
	Change the requirement for sulfur content from "0.05" to read "0.06" max., per cent
Classes H and I..	Add a requirement for phosphorus content of "0.055 max., per cent"
	Add a requirement for sulfur content of "0.06 max., per cent"

Section 7 (b).—Omit the requirements concerning residual chromium and nickel in class F forgings.

Section 9.—Omit Paragraph (*b*) of this section.

Table II.—Omit the tensile strength and yield point requirements for class A forgings.

Add the following requirements as to tensile properties for classes H and I forgings:

Class	Size: Solid Diameter or Thickness, in. Over	Size: Solid Diameter or Thickness, in. Not Over	Size: Bored Wall Thickness, in. Over	Size: Bored Wall Thickness, in. Not Over	Tensile Strength, min., psi.	Yield Point, min., psi.	Elongation in 2 in., min., per cent	Reduction of Area, min., per cent
H Quenched and Tempered	..	7	..	..	115 000	75 000	16	35
	7	10	..	4	105 000	65 000	18	35
	10	14	4	..	100 000	60 000	18	35
I Quenched and Tempered	..	7	..	..	130 000	80 000	13	30
	7	10	..	4	115 000	70 000	15	30
	10	14	4	..	110 000	65 000	16	30

Section 10 (d) and (e).—In the first sentence in both paragraphs after the reference to class G forgings add references to classes H and I.

EA – A 238
Issued, October 5, 1942

The following Emergency Alternate Provisions, when specified, may be used as alternates in A.S.T.M. Standard Specifications for Alloy-Steel Forgings for Locomotives and Cars (A 238 – 42) and affect only the requirements referred to:

Section 7 (a).—Change the present requirements for phosphorus and sulfur from their present form: namely,

Phosphorus, max., per cent	0.045
Sulfur, max., per cent	0.05

to read as follows:

Phosphorus, max., per cent	basic steel	0.045
	acid steel	0.055
Sulfur, max., per cent	basic steel	0.05
	acid steel	0.06

Section 14.—Omit this section which describes the procedure for the macroscopic examination.

EA – A 249
Issued, August 24, 1942

The following Emergency Alternate Provisions, when specified, may be used as alternates in A.S.T.M. Tentative Specifications for Atomic-Hydrogen-Arc-Welded and Electric-Resistance-Welded Alloy-Steel Boiler and Superheater Tubes (A 249 – 42T) and affect only the requirements referred to:

Table I.—Change the requirements for grades T 18 and T 19 to read as follows:

	Grade T 18	Grade T 19
Carbon, max., per cent	0.10	0.10
Manganese, max., per cent	2.50	2.50
Phosphorus, max., per cent	0.04	0.04
Sulfur, max., per cent	0.04	0.04
Silicon, max., per cent	0.75	0.75
Nickel, min., per cent	9.00	9.50
Chromium, min., per cent	17.00	17.00
Titanium, per cent	*a*	....
Columbium, per cent	....	*b*

a Grade T 18 shall have a titanium content of not less than four times the carbon content and not more than 0.60 per cent.

b Grade T 19 shall have a columbium content of not less than eight times the carbon content and not more than 100 per cent.

EA – A 250
Issued, August 24, 1942

The following Emergency Alternate Provisions, when specified, may be used as alternates in A.S.T.M. Tentative Specifications for Electric-Resistance-Welded Carbon-Molybdenum Alloy-Steel Boiler and Superheater Tubes (A250 – 41 T) and affect only the requirements referred to:

Table I.—Change the molybdenum requirements for grades T1, T1a, and T1b from "0.45 to 0.65" to read "0.40 to 0.55" per cent.

Section 19 (a).—Change to read as follows by the omission of the words in brackets:

19. (*a*) The name or brand of the manufacture, the identification symbol (T1, T1a, or T1b) of the grade of material from which it is made [the words Electric-Resistance-Welded Steel], A.S.T.M. Specifications A 250, together with the hydrostatic test pressure in pounds per square inch, shall be legibly stenciled on each tube $1\frac{1}{4}$ in. and over in outside diameter, provided the length is not under 3 ft.

EA – B 86a

(Zinc-Base Alloy Die Castings) Details in December BULLETIN.

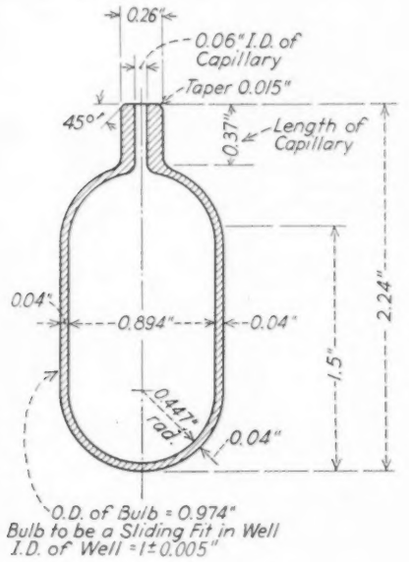
EA – D 524

Issued, July 29, 1942

Due to the shortage of stainless steel, the following Emergency Alternate Provision, when specified, may be used as an alternate in A.S.T.M. Standard Method of Test for Carbon Residue of Petroleum Products (Ramsbottom Carbon Residue) (D 524 – 42) and affects only the requirements referred to:

Section 2 (b).—A glass coking bulb conforming to the following approximate dimensions may be used as a substitute for the stainless steel bulb now prescribed in this method:

(*b*) *Coking Bulb.*—A coking bulb, made of heat-resistant glass, having an approximately hemispherical bottom and with the upper end terminating in a capillary, having the approximate dimensions as shown in the accompanying Fig. 1.



Conversion Table

Inches	Millimeters
2.24	57
1.5	38
1	25.4
0.894	22.6
0.447	11.3
0.37	9.5
0.06	1.5
0.04	1.0
0.005	0.13

FIG. 1.—Alternate Coking Bulb of Heat-Resistant Glass.

Section 3.—Substitute the following for the first three sentences of this section:

Weigh a clean coking bulb, dried in a desiccator, to the nearest 0.1 mg., introduce the sample of oil (Note 3) into the bulb, and weigh the bulb and sample, care being taken that no oil remains on the outside of the bulb. Place the bulb containing the sample in the bulb well in the bath maintained at a temperature of 1022 ± 9 F. (660 ± 5 C.) and allow to remain for 20 min.

Note 3.—Add the following to Note 3:

The sample may be introduced into the glass bulb by means of a pipette with a fine tip or by warming the glass bulb and then inserting it into the oil. It is permissible to heat the sample to facilitate introduction into the glass bulb. In this case, care shall be taken to cool the bulb before reweighing.

EA – D 607

Issued, September 16, 1942

The following Emergency Alternate Provision, when specified, may be used as an alternate in A.S.T.M. Tentative Specifications for Mica Pigment (D 607 – 41 T) and affect only the requirements referred to:

Section 2 (a).—Change the requirement for total residue retained on a No. 325 sieve from:

Total residue retained on a No. 325 (44-micron) sieve..... 7.0

to read as follows:

Total residue on a No. 325 (44-micron) sieve.....10.0

Color Manual and Index

RECENTLY PUBLISHED by the Color Laboratories Division, Container Corporation of America, 111 W. Washington Blvd., Chicago, Ill., is a Color Harmony Manual comprising 13 linen bound handbooks—12 of which are book charts, with 680 movable color chips based on the Ostwald theory. No. 13 is a text by Egbert Jacobson which explains the theory and tells how the charts may be used. These color chips, sprayed on acetate, provide the colorist with 680 colors organized for the ready location of harmonious combinations. Each chip is marked with a notation so that it can easily be taken out for matching. Cost of the 13 books, postage prepaid, is $50.

Simultaneously with the publication of the Manual is a Color Index indicator, colors for which were developed by Carl E. Foss from colorimetric specifications. The large telephone type unit is 28 inches long with 14 cards in each of the 6 compartments and 8 chips to the card. The chips are measured, numbered, and arranged on the basis of perceptional equidistance and according to all the other important and well-known interval relationships. For example, a 24-color circle of equal valence is quickly located by opening 3 compartments with the indicator at the same symbol. A charge of $325 is made for the Index which includes a specially fitted leather case with a book of instructions and charts.

INDEX TO ADVERTISERS

Agfa Ansco..... 63
American Beam Tester Co..... 68
American Instrument Co..... 66
Amthor Testing Instrument Co..... 66
Atlas Electric Devices Co..... 65
Baldwin-Southwark Corp.....Inside Front Cover
Bausch & Lomb Optical Co.....Outside Back Cover
Central Scientific Co..... 70
Corning Glass Works..... 71
Dietert Co., Harry W..... 68
Eimer & Amend, Inc..... 72
Fisher Scientific Co..... 72
Greiner Co., The Emil..... 65
Kelley-Koett Mfg. Co., The..... 67
Kimble Glass Co..... 2
Lancaster Iron Works, Inc..... 69
Leeds & Northrup Co..... 62
Morehouse Machine Co..... 72
National Carbon Co..... 4
Olsen Testing Machine Co., Tinius...Inside Back Cover
Perkins & Son Co., B. F..... 64
RiehleTesting Machine Division, American Machine & Metals, Inc..... 3
Sargent & Co., E. H..... 62
Taber Instrument Corp..... 64
Taylor and Co., W. A..... 66
Thomas Co., Arthur H..... 70
Wilson Mechanical Instrument Co., Inc..... 64

Professional Cards..... 61

NEW MEMBERS TO OCTOBER 15, 1942

The following 96 members were elected from July 16 to October 15, 1942:

Chicago District

DILLON AND CO., INC., W. C., W. C. Dillon, President, 5410 W. Harrison, Chicago, Ill.

ALLEY, HAROLD R., Technical Director, Tested Papers of America, Inc., Room 920, 230 N. Michigan Boulevard, Chicago, Ill.

JOHNSON, JOHN A., Mechanical and Electrical Engineer, Chicago Bridge and Iron Co., 1305 W. 105th St., Chicago, Ill.

PARDEE, HARVEY S., Owner, Harvey S. Pardee and Associates, 1512 W. Lake St., Chicago, Ill.

Cleveland District

AMERICAN VITRIFIED PRODUCTS CO., C. H. Miller, Treasurer, 1500 Union Commerce Building, Cleveland, Ohio.

BYERLYTE CORP., E. J. Fisher, Superintendent, 2300 W. Third St., Cleveland, Ohio.

MEISSE LABORATORIES, L. A. Meisse, Technical Director, 73 S. Walnut St., Mansfield, Ohio.

FOX, WILLIAM C., Chief Metallurgist, Empire Sheet and Tin Plate Co., Mansfield, Ohio. For mail: 510 Crescent Road, Mansfield, Ohio.

HIGGINS, JAMES J., Second Lieutenant, U. S. Army Engineers, 431 State Ave., N. E., Massillon, Ohio. [J]*

SUTHERLAND, JAMES L., Metallurgist, Youngstown Steel Door Co., Youngstown, Ohio For mail: 277 Lora Ave., Youngstown, Ohio.

Detroit District

NELSON, GEORGE P., Plant Manager, Precision Spring Corp., 15400 Woodrow Wilson, Detroit, Mich.

New York District

EASTERN AIRCRAFT, LINDEN DIVISION, GENERAL MOTORS CORP., E. P. Harris, Supervisor of Laboratories, Linden, N. J.

INDUSTRIAL FURNACE MANUFACTURERS ASSN., INC., W. M. Hepburn, 420 Lexington Ave., New York, N. Y.

UNITED STATES PLYWOOD CORP., Charles B. Hemming, Chief Chemist, Second St. and Beechwood Ave., New Rochelle, N. Y.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS, THE, A. B. Stickney, Chairman, Standards Committee, 50 W. Fortieth St., New York, N. Y.

CLARK, H. N., President, Refractory and Insulation Corp., 120 Wall St., New York, N. Y.

FRANKEL, SAMUEL, President, Foundry Services, Inc., 280 Madison Ave., New York, N. Y.

HOPKINS, JOHN RAY, Inspector of Ordnance Materiel, U. S. Army, 20 Salter Place, Maplewood, N. J.

LYON, HERBERT S., Junior Administrator, Signal Corps, U. S. War Dept., Radar Laboratory, Camp Evans, Belmar, N. J. For mail: 511 First Ave., Asbury Park, N. J.

PATTERSON, EVERETT M., Director of Research, Waterbury Clock Co., Waterbury, Conn. For mail: Route 6, Middlebury Road, Middlebury, Conn.

SHANNON, J. J., Metallurgist, Jenkins Brothers, Inc., 510 Main St., Bridgeport, Conn.

SONNTAG, ALFRED, President, Sonntag Scientific Equipment Corp., 1 Seneca Place, Greenwich, Conn.

Northern California District

PERMANENTE METALS CORP., THE, George W. Billingsley, Chemist, Moss Landing, Calif.

ABRAHAMS, SAMUEL ALBERT, Factory Manager, Plant Rubber and Asbestos Works, 537 Brannan St., San Francisco, Calif.

GLOVER, CRYSTAL M., Research Engineer, Haddock Engineers Ltd., Pasadena, Calif. For mail: Box 363, San Clemente, Calif.

* [J]—denotes Junior Member.

Philadelphia District

BALDWIN-HILL CO., K. M. Ritchie, Research Director, 501 Klagg Ave., Trenton, N. J.

BELLCO GLASS, INC., William Kontes, Manager, 413 N. Fourth St., Vineland, N. J.

CRAMP SHIPBUILDING CO., W. M. Patterson, Engineer of Tests, Richmond and Norris Sts., Philadelphia, Pa.

DURITE PLASTICS, INC., Ernest E. Novotny, Manager of Operations, Frankford Station P. O., Philadelphia, Pa.

HEINTZ MANUFACTURING CO., F. J. Whitney, Jr., Metallurgist, Front St. and Olney Ave., Philadelphia, Pa.

ROBERTS & MANDER STOVE CO., Richard Edge, Master Mechanic, Hatboro, Pa.

CRUMRINE, GARTON L., Spectrographer, North American Smelting Co., Philadelphia, Pa. For mail: 202 S. Fifty-third St., Philadelphia, Pa.

DONACHIE, MATTHEW J., Chief Metallurgist, The Beryllium Corp. of Pennsylvania, Reading, Pa.

GAUSCH, A. J., Chief Chemist, Smith, Rudy and Co., 20 N. Third St., Philadelphia, Pa.

LATSHAW, ELMER, Engineer, The J. G. Brill Co., Sixty-second St. and Woodland Ave., Philadelphia, Pa.

SMITH, ANNING H., Sales Representative, Phelps Dodge Corp., New York, N. Y. For mail: 2605 Girard Trust Building, Philadelphia, Pa.

STOUT, HARRY HOWARD, JR., Major, Ordnance Dept., U. S. Army, Frankford Arsenal, Philadelphia, Pa.

Pittsburgh District

HUSSEY AND CO., C. G., DIVISION OF COPPER RANGE CO., 2850 Second Ave., Pittsburgh, Pa.

SMALLEY, OLIVER, President, Meehanite Metal Corp., 311 Ross St., Pittsburgh, Pa.

Southern California District

JOHNSTONE, L. I., Field Engineer, Graham Brothers, Inc., 4731 E. Fifty-second Drive, Los Angeles, Calif.

SPALDING, LUTHER P., Chief Research Engineer, North American Aviation, Inc., Inglewood, Calif.

TRIMBLE, CLINTON E., Physicist, Materials and Processes Division, Vultee Aircraft, Inc., Vultee Field, Downey, Calif. For mail: 3796 Degnan Boulevard, Los Angeles, Calif.

St. Louis District

SLIVKA, FRANCIS X., Principal, Francis X. Slivka and Associates, 1834 Lafayette Ave. St. Louis, Mo.

U. S. and Possessions

Other than A.S.T.M Districts

AMERICAN BOTTLERS OF CARBONATED BEVERAGES, Joseph F. Hale, Technical Service Director, 224 Southern Building, Washington, D. C.

ATLANTIC RAYON CORP., Walter E. Hildick, Works Manager, 86 Crary St., Providence, R. I.

BURDSAL CO., THE A., W. L. DeBruler, Superintendent, 206 S. Capitol Ave., Indianapolis, Ind.

BURLINGTON MILLS CORP., W. Bailey Sellars, Head, Quality Control Dept., South Elm St., Greensboro, N. C.

LOGAN-LONG CO., THE, M. C. Bothe, General Manager, Franklin, Warren County, Ohio.

LUKAS-HAROLD CORP., THE, Russell Fanning, Physicist, Box 988, Indianapolis, Ind.

MUTUAL CHEMICAL CO. OF AMERICA, Omar F. Tarr, Vice-President, 1348 Block St., Baltimore, Md.

NEBRASKA DEFENSE CORP., N. F. Pestal, Laboratory Director, Nebraska Ordnance Plant, Mead, Nebr.

NEVADA CONSOLIDATED COPPER CORP., H. W. Mossman, Metallurgist, Hurley, N. Mex.

REYNOLDS METALS CO., Thomas N. Peck, Supervisor, Metal Control Division, 2500 S. Third St., Louisville, Ky.

SOUTHERN PINE INSPECTION BUREAU, R. R. Cahal, Assistant Manager, 520 Canal Building, New Orleans, La.

TOBE DEUTSCHMANN CORP., C. W. Metcalf, Vice-President, Washington St., Canton, Mass.

ALEXANDER, G. N., Engineer, Armoured Fighting Vehicles Directorate, Ministry of Munitions, Australia. For mail: 1700 Massachusetts Ave., N. W., Washington, D. C.

BOBROWSKY, ALFRED R., Assistant Mechanical Engineer, Langley Memorial Aeronautical Laboratory, National Advisory Committee for Aeronautics, Langley Field, Va. For mail: 3701 Chesapeake Ave., Hampton, Va. [J]

DUPLAGA, EDMUND, Chemical Engineer, The Hercules Powder Co., Inc., Radford Ordnance Works, Radford, Va. For mail: Box 1052, Room 531, Radford Va. [J]

EVERHART, JOHN L., Engineer, National Bureau of Standardards, Washington, D. C. For mail: 8708 Colesville Road, Silver Spring, Md.

GRAVES, SHERMAN S., Chief Inspector, Cessna Aircraft Co., Wichita, Kans. For mail: 3501 E. Thirteenth St., Wichita Kans.

HOLLER, ALBERT C., Chemist, U. S. Metal Products Co., Erie, Pa. For mail: 1155 E. Thirtieth St., Erie, Pa. [J]

JACKSON, JOSEPH GRAY, Associate Metallurgist, Office Chief of Ordnance, Ordnance Dept., Artillery Branch, 2B527 Pentagon Building, Arlington, Va.

JARRETT, TRACY C., Chief Metallurgist, American Hammered Piston Ring Division of Koppers Co., Bush and Hamburg Sts., Baltimore, Md.

KANSAS STATE LIBRARY, Topeka, Kans.

MANOV, GEORGE G., Assistant Physical Chemist, Chemistry Division, National Bureau of Standards, Washington D. C.

MATHIEU, CRAIG A., Chemist, Mathieu and Sons Foundry Co., Box 166, Bridgman, Mich. [J]

McADOO, W. V., Assistant to the General Manager, Keystone Steel and Wire Co., Peoria, Ill.

MEYER, GARSON, Chief Chemist, Eastman Kodak Co., Camera Works, 333 State St., Rochester, N. Y.

MOORE, LUTHER E., Metallurgist, The Magnavox Co., Inc. Fort Wayne, Ind. For mail: 1702 Columbia Ave., Fort Wayne, Ind.

MUELLER, EUGENE F., Physicist, National Bureau of Standards, Washington, D. C.

PIEPER, A. O., Executive Vice-President, Heany Industrial Ceramic Corp., Rochester, N. Y. For mail: 105 Trevor Court Road, Rochester, N. Y.

SCHWEIGHOFER, HORST MARTIN, Mechanical Engineer, Corning Glass Works, Corning, N. Y. For mail: 316 W. Pulteney St., Corning, N. Y. [J]

SHIELDS, JAMES E., Research Chemist, Alox Corp., Box 556, Niagara Falls, N. Y.

SMITH, DANIEL F., Director, Shilstone Testing Laboratory, Inc., Box 1187, Colorado City, Tex.

STEWART, D. S., Manager, Birmingham District, Pittsburgh Testing Laboratory, 921 Fifth Ave. North, Birmingham, Ala.

THOMAS, JAMES R., Director of War Production, Pennsylvania-Dixie Cement Corp., Richard City, Tenn.

TWEEDIE, THOMAS CHALMERS, Metallurgical Investigator, Douglas Aircraft Co., Inc., Tulsa, Okla. For mail: 1609 E. Fourteenth St., Tulsa, Okla.

WATERBURY, J. E., President, H. Waterbury and Sons Co. Oriskany, N. Y.

WELLS, DAIN G., Metallurgist, Savage Arms Corp., Utica, N. Y.

WILLIAMS, J. HOWARD, Mechanical Engineer, Grinnell Co., 260 W. Exchange St., Providence, R. I.

WRAY, FRANKLIN N., Civil Engineer, U. S. Engineers, Mobile, Ala.

Other than U. S. and Its Possessions

FISHER & LUDLOW LIMITED, G. J. Hamnett, Chief Metallurgist, Albion Works, Rea St., Birmingham, 5, England.

GYPROC PRODUCTS LIMITED, W. Fletcher, Secretary, Westfield, Upper Singlewell Road, Gravesend, Kent, England.

MAGNESIUM ELEKTRON LIMITED, F. A. Fox, Chief Metallurgist, Clifton Junction, Swinton, Nr. Manchester, England.

S/A MOINHO SANTISTA, INDUSTRIAS GERAIS, Caixa postal 507, Sao Paulo, Brázil.

SOUTHERN PORTLAND CEMENT, LTD., Manager, Berrima, N. S. W., Australia.

CAMPBELL, ROBERT R., Metallurgist, McKinnon Industries Ltd., St. Catharines, Ont., Canada.

CRUMP, DAVID JAMES, Inspector (Metals), Canadian Car and Foundry Co., Ltd., Fort William, Ont., Canada. For mail: 224 N. Archibald St., Fort William, Ont., Canada.

DIAZ, LUIS F., Director, Cuerpo de Ingenieros de Minas, Correo Apartado 889, Lima, Peru.

LYSTER, H. M., General Manager, Dominion Welding Engineering Co., Ltd., 6896 Notre Dame St. East, Montreal, P. Q., Canada.

MELBOURNE AND METROPOLITAN BOARD OF WORKS, James A. McIntosh, Acting Engineer of Sewerage, 110 Spencer St., Melbourne, Victo ia, Australia.

SCHEUER, E., Chief Metallurgist, International Alloys, Ltd., Buckingham Ave., Trading Estate, Slough, England.

TOMLINSON, GEORGE H., II, Research Director, Howard Smith Paper Mills, Ltd., Cornwall, Ont., Canada.

WALTON, N. J., General Manager, Austral Bronze Co., Pty., Ltd., O'Riordan St., Alexandria, Sydney, N. S. W., Australia.

WALLACE, JOHN BRUCE, Director and General Manager, Die Casters, Ltd., 126 Cromwell St., Collingwood, N. 5, Victoria, Australia.

PERSONALS

* * * News items concerning the activities of our members will be welcomed for inclusion in this column.

V. H. LAWRENCE, formerly Assistant to the President, The Otis Steel Co., Riverside Works, Cleveland, Ohio, is now General Superintendent, Otis Works, Jones & Laughlin Steel Corp., Cleveland, Ohio.

A. B. SQUIRE is temporarily Project Manager, Sunflower Ordnance Works, Box 36, Kansas City, Mo. His permanent connection is Designing Engineer, William S. Lozier, Inc., Rochester, N. Y.

R. C. BOSTWICK who was Sales Engineer, Bond Manufacturing Corp., Wilmington, Del., is now Lieutenant, U. S. Naval Reserve, Detroit, Mich.

JUDSON F. VOGDES, JR., is now with the Pennsylvania Economy League as Director of the Philadelphia Committee. He was Engineer, Day & Zimmerman, Inc., Philadelphia, Pa.

G. A. Lux, formerly Research Associate for American Electroplaters' Society at the National Bureau of Standards, Washington, D. C., is now Development Engineer, Divine Brothers Co., Inc., Utica, N. Y.

R. C. RICH is connected with the Monsanto Chemical Co., Texas City, Texas, as Personnel Director.

ERNEST SCHELLER, who was Research Director, is now Assistant to the President, and General Manager of Foil Division, Reynolds Metals Co., Louisville, Ky.

M. C. VAN GUNDY, formerly Assistant Technologist, The Texas Company, is now Sales Engineer, Maintenance Engineering Co., Houston, Texas.

E. J. RUTAN, who was Test Engineer, Consolidated Edison Co. New York, Inc., New York, N. Y., is now Engineer, Chemical Construction Corp., New York, N. Y.

C. W. MACGREGOR has recently been promoted to a full professorship at Massachusetts Institute of Technology. He has been placed in charge of the Materials Division of the Mechanical Engineering Department comprising the testing of materials laboratories, foundry, welding, and the metal processing laboratories.

G. H. MILLER of N. R. Miller & Co., Textiles, Toronto, Canada, is now associated with the Wartime Prices and Trade Board, Trade Administration, Toronto, Canada.

LEO DANZKER, formerly Associate Inspector, Engineering Materials, c/o Naval Inspector of Ordnance, Chrysler Corp., Detroit, Mich., is now Assistant Specifications Specialist, Prod-

(Continued on page 58)

uct Control Division, Nebraska Defense Corp., Nebraska Ordnance Plant, Mead, Nebr.

J. O. Johnson, who was Chief Product Engineer of Aircraft-Marine Products, Inc., Elizabeth, N. J., has been made Assistant Merchandise Manager. In his new capacity, Mr. Johnson will be in complete charge of all engineering phases of customer relations in connection with the use and application of various solderless wiring devices as now manufactured by the company and also with regard to the design and development of new products for special requirements.

R. D. Landon, formerly Professor of Civil Engineering, Southern Methodist University, Dallas, Texas, is now Field Representative, E.S.M.W.T., U. S. Office of Education, Washington, D. C.

H. M. Rich who was Salesman, Hickman-Williams and Co., Inc., Detroit, Mich., is now Salesman, Electro Metallurgical Sales Corp., New York, N. Y.

E. A. Abdun-Nur is connected with the U. S. Engineer Office, Denver, Colo. He was formerly Associate Engineer, U. S. Department of the Interior, Civilian Conservation Corps, Indian Division, Billings, Mont.

R. H. Pierson, formerly Chief Chemist, Gilmore Oil Co., Los Angeles, Calif., is now Plant Manager, Marvin Corp., Los Angeles, Calif.

W. S. Housel, who was Associate Professor of Civil Engineering, University of Michigan, and Consultant, Michigan State Highway Dept., Ann Arbor, Mich., has been called to active duty with the U. S. Navy as Lieutenant Commander, (CEC) USNR, Office of Superintending Civil Engineer, Norfolk, Va.

J. E. Harrington, formerly Chemical Engineer, Greeley & Hansen, Consulting Engineers, Chicago, Ill., is now with the U. S. War Department, Office Chief of Ordnance, Security and Safety Branch as Chief of the High Explosives Manufacturing and Raw Materials Unit, Chicago, Ill.

E. H. Dix, Jr., Chief Metallurgist, and R. L. Templin, Chief Engineer of Tests, Aluminum Co. of America, New Kensington, Pa., have been made Assistant Directors of the Aluminum Company Research Laboratories.

E. B. Kindquist, who was Chemical Engineer, RCA Radiotron, Harrison, N. J., is now with Battelle Memorial Institute, Columbus, Ohio, as Research Engineer.

G. F. Jenks, recently retired from the U. S. Army, Ordnance Dept., is now with Taylor-Winfield Corp., Warren, Ohio.

R. W. Allan is now Chemist, M. Ewing Fox Co., New York, N. Y. He was formerly with The American Gum Importers Assn., Inc., Brooklyn, N. Y., as Chemist.

L. W. Walter, formerly secretary of Committee C-1 on Cement, and Consultant on Concrete, is now with the U. S. Maritime Inspection Office, c/o San Jacinto Shipbuilders, Inc., Houston, Texas. Mr. Walter, however, is maintaining his mailing address at 5 Boyd Ave., Jersey City, N. J.

C. B. Francis, Chemist and Metallurgist, Metallurgical Department, Pittsburgh District, Carnegie-Illinois Steel Corp., Pittsburgh, Pa., has been appointed on the technical committee for individual awards of the WPB. The committee will select the first list of workers in war plants to be honored by the Government for contributing valuable suggestions for increasing production.

The following A.S.T.M. members received awards in the $200,000 progress program of the James F. Lincoln arc welding foundation: J. H. Hruska, Chief Inspector, Electro-Motive Division, General Motors Corp., LaGrande, Ill.; C. G. Lutts, Materials Engineer, U. S. Navy Yard, Boston, Mass.; Paul Fiield, Materials Engineer, Bethlehem Steel Co., Quincy, Mass.; G. L. Yetter, Engineer, U. S. Department of the Interior, Bureau of Reclamation, Redding, Calif.; F. L. Plummer, Chief Research Engineer, Hammond Iron Works, Warren, Pa.; and J. J. Laudig, Research Engineer, Delaware, Lackawanna & Western Railroad Co., Scranton, Pa.

C. E. MacQuigg, Dean, College of Engineering and Director, Engineering Experiment Station, The Ohio State University, Columbus, Ohio, has been elected Vice-President of the Society for the Promotion of Engineering Education for the coming year.

N. B. Higgins, formerly Advisory Engineer, Pennsylvania Water and Power Co., and Chief Engineer of the Safe Harbor Water Power Corp., Baltimore, Md., has been made President and Director of the latter company.

The Federal Products Corp., Providence, R. I., has announced the appointment of F. C. Tanner, Vice-President, as General Manager of the corporation. He was formerly Manager of Engineering Sales.

G. W. Morey, formerly chairman of the Society's Committee C-14 on Glass and Glass Products, has taken leave of absence from the Geophysical Laboratory, Carnegie Institution of Washington, to become General Manager of the Parkersburg, W. Va., Division of the Corning Glass Works.

Bradley Dewey, formerly President, Dewey & Almy Chemical Co., Cambridge, Mass., has been appointed as Deputy Rubber Director, assisting W. M. Jeffers. Colonel Dewey was awarded a Distinguished Service Medal in World War I in connection with his work in the Chemical Warfare Service.

A. E. White, Director, Department of Engineering Research, and Professor of Metallurgical Engineering, University of Michigan, Ann Arbor, Mich., has been elected a Manager of The American Society of Mechanical Engineers, to serve on the Council for a three-year term.

New Publications on Welding

The American Welding Society, 33 W. 39th St., New York, N. Y., has recently issued a number of standards and special pamphlets covering various phases of welding. Copies of the publications briefly described below can be obtained from the A.W.S., at the prices indicated.

Standard Methods for Mechanical Testing of Welds describes in detail the principal mechanical tests applied to welds, including tests for density, soundness, tensile strength, shearing strength, and ductility (bend tests). Some of the tests apply to the weld metal alone; others apply to butt-welded joints and fillet-welded joints. There is a section on etching reagents and procedures for etching. Price, 40 cents.

Definitions of Welding Terms and Master Chart of Welding Processes gives the standard definitions of welding terms adopted by the A.W.S. The terms are grouped under appropriate headings so that related terms appear together. An index lists the terms alphabetically. Fifty-one illustrations are given. Price, 40 cents.

Report on Recommended Practices for Inspection of Fusion Welding is the result of two years' work, representing a comprehensive treatment of the many factors involved in the inspection of welds made by the arc and oxyacetylene processes. The subjects covered include: qualifications of welding inspectors; duties of inspectors; inspection and testing of welded structures; inspection during construction; shop and field inspections; examination of welds; radiographic inspection, hydrostatic testing, and magnetic powder inspection. A considerable part of the report deals with the welding characteristics of both ferrous and non-ferrous metals. 23 pages, 40 cents a copy.

Spot Welding of Aluminum Alloys in Aircraft, the result of nine months' concentrated work, presents tentative recommendations for standards of weld quality and performance and recommendations of the best practices in the aircraft industry. Covered are standards of weld quality, surface preparation, welding technique, methods of testing and inspection, design of spot-welded parts, welding equipments, and installation. Copies (48 pages) are priced at $1 each.

Code of Minimum Requirements for Instruction of Welding Operators, Part A—Arc Welding of Steel $^3/_{16}$ to $^3/_4$ in. Thick represents a revision of the 1941 "proposed code," which was reprinted by the War Production Board for use in defining an "Accredited School." The sections of the Code include: equipment and facilities of the school, qualifications and duties of the instructor, instruction in welding practice, instruction in welding theory, and final tests. There are nine appendices of suggested and recommended material. This 68-page booklet costs 50 cents a copy.

Complete List of A.S.T.M. Emergency Specifications and Emergency Alternate Provisions

EDITOR'S NOTE.—To provide a readily accessible and convenient reference for members who wish to have a complete list of all emergency specifications and emergency alternate provisions (pink slips) each issue of the BULLETIN will give the latest list at the time the BULLETIN goes to press. This feature suggested by the Executive Committee will appear as the last page or two of BULLETIN text immediately preceding the professional card page in the back advertising section.

October 21, 1942

Emergency Specifications for

ES–1a	Lead-Coated and Lead-Alloy Coated Copper Wire for Electrical Purposes.
ES–2	Lead Coating (Hot-Dip), on Iron or Steel Hardware.
ES–3	Conducting Salt Spray Tests on Organic Protective Coatings. (Method)
ES–4	*Discontinued*, Replaced by Standard Hardness Conversion Table for Cartridge Brass. (Relationship Between Diamond Pyramid Hardness, Rockwell Hardness, and Brinell Hardness) (E 33–42)
ES–5a	Carbon-Chromium Ball and Roller-Bearing Steels.
ES–6	Rubber Sheath Compound for Electrical Insulated Cords and Cables Where Extreme Abrasion Resistance Is Not Required.
ES–7	Fire-Refined Copper for Wrought Products and Alloys.
ES–8	85 Per Cent Magnesia Thermal Insulating Cement.
ES–9	Long Fiber Asbestos Thermal Insulating Cement.
ES–10	Mineral Wool Thermal Insulating Cement.
ES–11	Expanded or Exfoliated Mica Thermal Insulating Cement.
ES–12	Diatomaceous Earth Thermal Insulating Cement, for use from 600 to 1200 F.
ES–13	Diatomaceous Earth Thermal Insulating Cement, for Use from 1200 to 1900 F.
ES–14	Blanket Thermal Insulation for Building Purposes.
ES–15	Blanket Thermal Insulation for Industrial Purposes.
ES–16	Blanket Thermal Insulation for Refrigeration.
ES–17	Preformed Pipe Covering Thermal Insulation.
ES–18	Preformed Block Thermal Insulation.
ES–19	Structural Board Thermal Insulation.
ES–20	Malleable Iron Flange, Pipe Fittings, and Valve Parts.

Emergency Alternate Provisions in Specifications for

Steel

EA–A 1	Open-Hearth Carbon-Steel Rails (A 1–39).
EA–A 21	Carbon-Steel Axles for Cars and Tenders (A 21–39).
EA–A 25a	Wrought Steel Wheels for Electric Railway Service (A 25–41).
EA–A 26	Steel Tires (A 26–39).
EA–A 27	Carbon-Steel Castings for Miscellaneous Industrial Uses (A 27–42).
EA–A 57	Multiple-Wear Wrought Steel Wheels (A 57–39).
EA–A 67	Steel Tie Plates (A 67–33).
EA–A 83	Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes (A 83–42).
EA–A 87	Carbon-Steel and Alloy-Steel Castings for Railroads (A 87–42).
EA–A 120	Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses (A 120–42).
EA–A 134	Electric-Fusion-Welded Steel Pipe (Sizes 30 in. and Over) (A 134–42).
EA–A 135	Electric-Resistance-Welded Steel Pipe (A 135–42).
EA–A 139	Electric-Fusion-Welded Steel Pipe (Sizes 8 in. to but not Including 30 in.) (A 139–42).
EA–A 148	Alloy-Steel Castings for Structural Purposes (A 148–42).
EA–A 160	Axle-Steel Bars for Concrete Reinforcement (A 160–39).
EA–A 161	Seamless Low-Carbon and Carbon-Molybdenum Steel Still Tubes for Refinery Service (A 161–40).
EA–A 167	Corrosion-Resisting Chromium-Nickle Steel Sheet, Strip, and Plate (A 167–42).
EA–A 177	High-Strength Corrosion-Resisting Chromium-Nickel Steel Sheet and Strip (A 177–42).
EA–A 178	Electric-Resistance-Welded Steel and Open-Hearth Iron Boiler Tubes (A 178–40).
EA–A 179	Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes (A 179–42).
EA–A 183	Heat-Treated Carbon- and Alloy-Steel Track Bolts and Nuts (A 183–40 T).
EA–A 186	One-Wear and Two-Wear Wrought Steel Wheels (A 186–39).
EA–A 190	Lightweight and Thin-Sectioned Gray-Iron Castings (A 190–40).
EA–A 192	Seamless Steel Boiler Tubes for High-Pressure Service (A 192–40).
EA–A 194	Carbon and Alloy-Steel Nuts for Bolts for High-Pressure and High-Temperature Service to 1100 F. (A 194–40).
EA–A 199	Seamless Cold-Drawn Intermediate Alloy-Steel Heat-Exchanger and Condenser Tubes (A 199–40).
EA–A 200	Seamless Intermediate Alloy-Steel Still Tubes for Refinery Service (A 200–40).
EA–A 209	Seamless Carbon-Molybdenum Alloy-Steel Boiler and Superheater Tubes (A 209–42).
EA–A 211	Spiral-Welded Steel or Iron Pipe (A 211–40).
EA–A 213	Seamless Alloy-Steel Boiler and Superheater Tubes (A 213–42).
EA–A 214	Electric-Resistance-Welded Steel Heat-Exchanger and Condenser Tubes (A 214–42).
EA–A 215	Carbon-Steel Castings Suitable for Fusion Welding for Miscellaneous Industrial Uses (A 215–41).
EA–A 216	Carbon-Steel Castings Suitable for Fusion Welding for Service up to 850 F. (A 216–42 T).
EA–A 217	Alloy-Steel Castings Suitable for Fusion Welding for Service from 750 to 1100 F. (A 217–42 T).
EA–A 226	Electric-Resistance-Welded Steel Boiler and Superheater Tubes for High-Pressure Service (A 226–40).
EA–A 227	Hard-Drawn Steel Spring Wire (A 227–41).
EA–A 229	Oil-Tempered Steel Spring Wire (A 229–41).
EA–A 230	Carbon-Steel Valve Spring Quality Wire (A 230–41).
EA–A 236	Carbon-Steel Forgings for Locomotives and Cars (A 236–42).
EA–A 238	Alloy-Steel Forgings for Locomotives and Cars (A 238–42).
EA–A 240	Corrosion-Resisting, Chromium and Chromium-Nickel Steel Sheet, Strip, and Plate for Fusion-Welded Unfired Pressure Vessels (A 240–42).
EA–A 241	Hot-Worked High-Carbon Steel Tie Plates (A 241–41).
EA–A 244	Heat-Treated Wrought Steel Wheels (A 244–42).
EA–A 249	Atomic-Hydrogen-Arc-Welded and Electric-Resistance-Welded Alloy-Steel Boiler and Superheater Tubes (A 249–42).
EA–A 250	Electric-Resistance-Welded Carbon-Molybdenum Alloy-Steel Boiler and Superheater Tubes (A 250–41 T).

Non-Ferrous Metals and Alloys

EA–B 23	White Metal Bearing Alloys (Known Commercially as "Babbitt Metal") (B 23–26).
EA–B 30	Copper-Base Alloys in Ingot Form for Sand Castings (B 30–42 T).
EA–B 32	Soft Solder Metal (B 32–40 T).
EA–B 60	Castings of the Alloy: Copper 88 per cent, Tin 8 per cent, Zinc 4 per cent (B 60–41).
EA–B 62	Composition Brass or Ounce Metal Castings (B 62–41).
EA–B 85	Aluminum-Base Alloy Die Castings (B 85–42).
EA–B 86a	Zinc-Base Alloy Die Castings (B 86–41 T).
EA–B 143	Tin-Bronze and Leaded Tin-Bronze Sand Castings (B 143 – 42 T).
EA–B 144	High-Leaded Tin-Bronze Sand Castings (B 144–42 T).
EA–B 145	Leaded Red Brass and Leaded Semi Red Brass Sand Castings (B 145–42 T).
EA–B 146	Leaded Yellow Brass Sand Castings for General Purposes (B 146–42 T).
EA–B 148	Aluminum-Bronze Sand Castings (B 148–42 T).

("C" and "D" groups on next page)

"C" and "D" Groups

EA–C 150 Portland Cement (C 150–42).
EA–D 27a Insulated Wire and Cable: Class AO, 30 per cent Hevea Rubber Compound (D 27–41).
EA–D 224 Asphalt Roofing Surfaced with Powdered Talc or Mica (D 224–41 T).
EA–D 249 Asphalt Roofing Surfaced with Coarse Mineral Granules (D 249–41 T).
EA–D 353 Insulated Wire and Cable: Performance Rubber Compound (D 353–41).
EA–D 375 Test for Asbestos Roving for Electrical Purposes (D 375–42). (Specifications and Methods)
EA–D 445 Milled Toilet Soap (D 455–39).
EA–D 469 Insulated Wire and Cable: Heat-Resisting Rubber Compound (D 469–41).
EA–D 499 White Floating Toilet Soap (D 499–39).
EA–D 524 Test for Carbon Residue of Petroleum Products (Ramsbottom Carbon Residue) (D 524–42).
EA–D 532 Rubber Sheath Compound for Electrical Insulated Cords and Cables (D 532–39 T).
EA–D 533 Built Soap, Powdered (D 533–41).
EA–D 535 Palm Oil Solid Soap (Type A, Pure; Type B, Blended) (D 535–41).
EA–D 536 Palm Oil Chip Soap (Type A, Pure; Type B, Blended) (D 536–42).
EA–D 574 Insulated Wire and Cable: Ozone-Resistant Type Insulation) (D 574–40 T).
EA–D 592 Olive Oil Solid Soap (Type A, Pure; Type B, Blended) (D 592–42).
EA–D 593 Salt-Water Soap (D 593–42).
EA–D 607 Mica Pigment (D 607–42).
EA–D 630 Olive Oil Chip Soap (Type A, Pure; Type B, Blended) (D 630–42).

NECROLOGY

We announce with regret the death of the following members and representatives:

WALTER S. ADAMS, Designing Engineer, The J. G. Brill Co., Philadelphia, Pa. Member since 1920.

RAYMOND HEWES DANFORTH, Professor of Mechanics and Materials, In Charge of Warner Laboratories of Mechanics, Hydraulics, Aerodynamics and Materials, Case School of Applied Science, Cleveland, Ohio. Member since 1916. Professor Danforth was a member of the Cleveland District Committee.

ALFRED N. FINN, Chief, Glass Section, National Bureau of Standards, Washington, D. C. Member since 1937. At the time of his death Mr. Finn was a member of Committee C-14 on Glass and Glass Products and several of its subcommittees. Formerly he was a member of Committee D-9 on Electrical Insulating Materials and its Subcommittee V.

BENJAMIN FOSTER, President, Benjamin Foster Co., Twentieth St. and Erie Ave., Philadelphia, Pa. Member since 1929.

JOHN LYLE HARRINGTON, Harrington & Cortelyou, Consulting Engineers, Kansas City, Mo. Member since 1916.

FRANK W. HARRIS, Supervisor of Methods, Revere Copper and Brass Incorporated, Michigan Division, Detroit, Mich. Member since 1935.

ERNEST F. HARTMAN, President, Protexol Corp., Kenilworth, N. J. Member since 1914. Mr. Hartman was a member of Committee C-5 on Fire Tests of Materials and Construction, and several of its subcommittees. A tribute prepared by the chairman of Committee C-5 appears on this page.

A. C. HARVEY, Chief Engineer, The New York, Chicago and St. Louis Railroad Co., Cleveland, Ohio.

C. W. LAPORTE, Vice-President, Keystone Steel and Wire Co., Peoria, Ill. Member since 1927. Mr. LaPorte served for many years on Committee A-5 on Corrosion of Iron and Steel, and was a member of Subcommittees VI on Specifications for Metallic-Coated Products, VII on Methods of Testing, and VIII on Field Tests of Metallic Coatings.

J. A. MILLSOM, Vice-President and General Manager, W. S. Dickey Clay Manufacturing Co., Kansas City, Mo. Member since 1935. Mr. Millsom was a member of Committee C-4 on Clay Pipe from 1935 till the time of his death and was a member of Subcommittees I on Nomenclature and II on Specifications.

E. W. P. SMITH, Consulting Engineer, The Lincoln Electric Co., 12818 Coit Road, Cleveland, Ohio. Member since 1936. Mr. Smith was a member of Committee A-1 on Steel and represented The Lincoln Electric Company on the new Joint AWS-A.S.T.M. Committee on Filler Metal.

WILLIAM H. SWANGER, Metallurgist, National Bureau of Standards, Washington, D. C. Member since 1937. Mr. Swanger served on several of the Society's committees, namely A-1 on Steel and Subcommittee XIII on Methods of Physical Tests; B-2 on Non-Ferrous Metals and Alloys and Subcommittees III on White Metal Alloys and VI on Coated Metals; B-5 on Copper and Copper Alloys, Cast and Wrought and several of its subcommittees; B-6 on Die-Cast Metals and Alloys and Subcommittees I on Aluminum-Base Die-Casting Alloys and III on Tin- and Lead-Base Die-Casting Alloys; E-4 on Metallography, Subcommittees IV on Photography, VIII on Grain Size, and IX on Inclusions. He also served as an alternate for H. S. Rawdon on the Research Committee on Fatigue of Metals. Mr. Swanger was awarded the Dudley Medal in 1937 for his outstanding paper (with G. F. Wohlgemuth) on the Mt. Hope suspension bridge cable failure.

ARTHUR H. THOMAS, President, Arthur H. Thomas Co., Philadelphia, Pa. Mr. Thomas, a leading figure in the instrument and laboratory apparatus field, had represented his company since 1921.

H. VANDERWERP, Vice-President, in Charge of Operations, Medusa Portland Cement Co., Cleveland, Ohio. Mr. Vanderwerp represented his company in its sustaining membership in the Society and on Committee C-1 on Cement and the Working Committee on Sulfate Resistance and the Sponsoring Committee on Masonry Cements. He has been succeeded in the Society and committee membership by his son, Harry L. Vanderwerp, Chief Chemist.

JOHN F. WYZALEK, Chief Metallurgist, Hyatt Bearings Division, General Motors Corp., Harrison, N. J. Mr. Wyzalek represented his company in its membership on Committee A-1 on Steel and subcommittees; also E-4 on Metallography and several subcommittees.

Ernest F. Hartman

In the death, on September 30, 1942, of Ernest F. Hartman, Committee C-5 has lost an active and outstanding member. His membership on the committee started in June, 1930; he had been a member of the Society since 1914. His wide knowledge of the characteristics of woods of all kinds and his practical experience in the treatment of the material to assure its preservation against decay and destruction by insects and in the development of effective impregnation to render it fire-resistive made him an interested and helpful member of Subcommittee II on Fire Tests of Lumber. When in March, 1932, the organization of Subcommittee VI on Fire Tests of Scaffolding was authorized Mr. Hartman was appointed chairman and as such conducted its activities until the general reorganization of all subcommittees in 1936, though he continued as a member of the subcommittee up to the time of his death. He was also a member of Subcommittee III on Fire Tests of Wall Opening Protectives and Subcommittee V on Nomenclature and Definitions.

Mr. Hartman was born in Germany sixty-four years ago. At the age of twelve his parents brought him to the United States, settling in Milwaukee. His civic life was a varied one. He practiced law for some years, took up engineering for a while, entered the service of the U. S. military forces at the time of the Spanish-American War and finally established, about the time of the World War of 1916–18, the Protexol Corporation of Kenilworth, N. J.

Surviving him are his wife, his mother, a daughter and two sons. Another son was killed last December in the defense of Manila, Philippine Islands.

RUDOLPH P. MILLER, *Chairman, Committee C-5*